ENSAFE

ENSAFE INC. ENVIRONMENTAL AND MANAGEMENT CONSULTANTS

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September 9, 2005

Mr. Femi Akindele
Remedial Project Manager, USEPA Region 4
Atlanta Federal Center
61 Forsyth Street S.W.
Atlanta, GA 30303-8960

Re: Carrier Air Conditioning Superfund Site
Collierville, Tennessee
2004 Five-Year Review, Revision 2

Dear Mr. Akindele:

On behalf of United Technologies-Carrier Corporation, EnSafe Inc. is pleased to transmit the final, signed version of *2004 Five-Year Review.* Per your request, we have sent you a hardcopy and a CD version of the report; we have provided the same material to Jamie Woods at TDEC-DoR.

As we indicated by voice- and electronic-mail earlier today, there is some confusion regarding the Collierville Public Library's retention of the Carrier information repository. We are holding the local repository document until this issue is resolved.

If you have any questions or comments, please do not hesitate to contact me at 901/372-7962 or lgoetz@ensafe.com.

Sincerely,

EnSafe Inc.

By: Lori Anne Goetz
Project Manager

Enclosure

cc: Mr. Bryan Kielbania, UTC – Carrier (hardcopy and CD)
Ms. Mary C. Johnson, USEPA (CD)
Mr. Jamie Woods, TDEC (hardcopy and CD)

2004 FIVE-YEAR REVIEW
Revision: 2

CARRIER AIR CONDITIONING SITE
COLLIERVILLE, TENNESSEE

Main Text and Appendix A

Prepared for:

United Technologies

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June 2005

Executive Summary

This document presents the second Five-Year Review of the Carrier Air Conditioning Superfund Site in Collierville, Tennessee. The Review has been conducted to evaluate the effectiveness of the on-going Remedial Action (RA) at the site. The first Review of the RA was completed in August 2000. The site contains an active air conditioning manufacturing plant.

Carrier was placed on the NPL in 1990. The primary contaminant at the site is trichloroethylene (TCE) which has affected site soil and groundwater in the area. The RA includes Soil Vapor Extraction (SVE) and Air Stripping. The construction of the main facilities for these processes was initiated in 1989, and completed in 1995. A significant component of the facilities is the two extraction wells for the Town of Collierville's Water Plant #2 which supplies part of the potable water used by the public. These wells were installed by the Town in 1967. They were incorporated into the Carrier remedial system in 1990. Producing these wells helps to contain the TCE plume. TCE in the produced water is removed by air stripping before the water enters the plant for distribution to the public.

The 2000 Five-Year Review concluded that the RA was functioning as intended and was protective of human health and the environment. That Review identified a number of concerns which needed to be addressed to ensure that the RA would continue to function properly. In the current Review, it is noted that most of the concerns have been addressed appropriately.

Soil sampling and analyses conducted since the 2000 Review indicate that TCE remains above the cleanup goal of 533 ppb. As part of a manufacturing plant expansion project, Carrier recently proposed to EPA and the State to re-construct the SVE system. The agencies evaluated the proposal as part of this Five-Year Review and determined that it would enhance the effectiveness of the SVE process when implemented. The re-construction is currently in progress.

Groundwater remediation is far from being complete. However, it has progressed satisfactorily as indicated by the results of monitoring well sampling and analyses. The monitoring wells which are downgradient from the Collierville wells have shown no detection of TCE indicating that the Collierville wells are effectively containing the TCE plume. Unfortunately, this condition is being threatened by the presence of chromium in increasing concentration in the Collierville wells. The chromium has been linked to a newly listed site which is near Carrier.

Carrier continues to ensure that its site remains protective of human health and the environment by solely addressing the issue of extraneous chromium in the groundwater it treats for TCE. Collierville's wells must be produced to maintain containment of the TCE plume but the Town would not allow the water with any amount of chromium in its potable water system. Therefore, the water being treated for TCE by Carrier currently goes to the Publicly Owned Treatment Works under a temporary arrangement between Carrier and the Town.

The main recommendations resulting from this evaluation of current site conditions are:

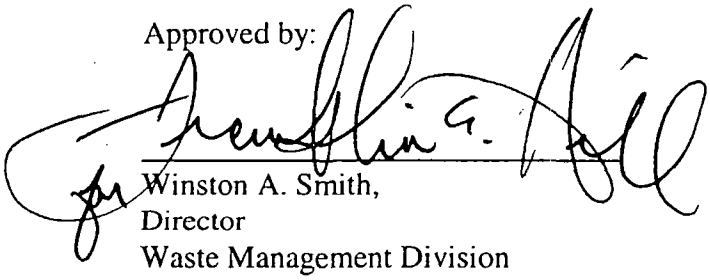
1. A permanent solution to the issue of chromium in the water treated for TCE at Carrier must be found in the near future. Control of the chromium at its source needs to be initiated as soon as possible. This would call for accelerating the on-going Remedial Investigation/Feasibility Study and initiating an Interim Remedial Action at the newly listed Smalley-Piper site which appears to be the source of the chromium affecting Carrier operations. Carrier must continue to ensure that the two Collierville wells are produced at the rate necessary to contain the TCE plume.

2. Monitoring well MW-31 was destroyed by the Tennessee Department of Transportation during road construction in 1999/2000. Elevated levels of TCE, lead and zinc were detected in the shallow groundwater monitored by the well prior to its permanent destruction and it has not been replaced. Carrier should evaluate the status of the well relative to its intended use for this RA and determine if it should be replaced or not.

Protectiveness Statement:

The remedy at the Carrier Site currently protects human health and the environment. The soil and groundwater affected by site contaminants are undergoing effective remedial operations. If the recommendations outlined above are properly addressed, the remedy should continue to meet its objectives.

Approved by:



Winston A. Smith,
Director
Waste Management Division
U. S. EPA, Region 4

6/27/05
Date

Five-Year Review Summary Form

SITE NAME: Carrier Air Conditioning
EPA ID# : TND044062222
SITE IDENTIFICATION
REGION: IV **STATE**: TN **CITY**: Collierville **COUNTY**: Shelby
SITE STATUS
NPL STATUS: Active **REMEDIATION STATUS**: Active
ACTIVITY IN PROGRESS: Soil and Groundwater Remedial Action
HOW MANY OUs?: 1 **CONSTRUCTION COMPLETION DATE**: 10/31/95
IS THE SITE IN RE-USE?: Yes; Active Manufacturing Plant
REVIEW STATUS
LEAD AGENCY: USEPA
AUTHOR/AFFILIATION: Lori Goetz/Ensafe and Bruce Cliff/Xpert Design and Diagnostics
PERIOD REVIEWED: 8/2000-4/2005
SITE INSPECTION DATE: 9/22/2004
REVIEW TYPE: Statutory **REVIEW NUMBER**: 2
TRIGGERING ACTION & DATE: First Five-Year Review–8/28/2000
REVIEW DUE DATE IN CERCLIS: 8/28/2005
DATE REVIEW STARTED: 8/2004 **DATE REVIEW COMPLETED**: 5/2005

Table of Contents

List of Tables

List of Appendices

Acronym List

$\mu g/m^3$	micrograms per cubic meter
ARAR	applicable or relevant and appropriate requirement
ATDSR	Agency for Toxic Diseases and Substance Registry
bgs	below ground surface
BRA	Baseline Risk Assessment
Carrier	UTC-Carrier Corporation
CERCLA	Comprehensive Environmental Responses, Compensation, and Liability Act
cfm	cubic feet per minute
CFR	Code of Federal Regulations
COC	contaminant of concern
DCE	dichloroethylene
DPT	direct push technology
DSF	Division of Superfund
DWS	Division of Water Supply
FS	Feasibility Study
gpm	gallons per minute
HI	Hazard Index
hp	horsepower
ID	inner diameter
ILCR	incremental lifetime cancer risk
lbs	pounds
lbs/day	pounds per day
lfm	linear feet per minute
m^3/min	cubic meters per minute
MCL	maximum containment level
MCLG	maximum containment level goal
MGD	million gallons per day
MPA	main plant area
MSCHD	Memphis and Shelby County Health Department
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NPDES	National Pollutant Discharge Elimination System
NPL	national priorities list
NRS	north remediation system

O&M	Operations & Maintenance
OSHA	Occupational Safety and Health Act
PCE	tetrachloroethylene
PID	photoionization detector
POTW	publicly owned treatment works
ppm	parts per million
PRP	Potentially Responsible Party
PVC	polyvinyl chloride
RAO	remedial action objective
RD/RA	remedial design/remedial action
RI	remedial investigation
ROD	record of decision
ROI	radius of influence
SARA	Superfund Amendments and Reauthorization Act
SAS	SAS Environmental, Inc.
SCH	schedule
SDWA	Safe Drinking Water Act
Site	Carrier Air Conditioning Superfund Site, Collierville, Tennessee
SMP	Soil Management Plan
SOW	scope of work
SSV	sub-slab ventilation
SVE	soil vapor extraction
TBCs	to-be-considered criteria
TCE	trichloroethylene
TDEC	Tennessee Department of Environment and Conservation
TDHE	Tennessee Department of Health and the Environment
TDOT	Tennessee Department of Transportation
VOC	volatile organic compound
USEPA	U.S. Environmental Protection Agency
UTC	United Technologies Corporation
VOC	volatile organic compound
XDD	Xpert Design and Diagnostics, LLC
WPC	Water Pollution Control

1.0 INTRODUCTION

United Technologies Corporation (UTC), Carrier Air Conditioning Corporation (Carrier), at the request of the U.S. Environmental Protection Agency (USEPA) Region 4, has conducted a 5-year review of the soil and groundwater remedial actions implemented at Carrier Air Conditioning Superfund Site, Collierville, Tennessee (Site). This review was conducted between August 1, 2004 and October 31, 2004 by EnSafe Inc. and Xpert Design and Diagnostics, LLC (XDD), environmental consultants for UTC, and is documented in this report.[1]

This is the second 5-year review conducted for the Site; the first was completed in 2000 (USEPA, 2000). This 5-year review was triggered by the signature date on the 2000 Five-Year Review (USEPA, 2000), but was completed early to discuss facility expansion activities initiated in 2004 and summarized in the *Scope of Work: Reconstruction of Main Plant Area Remedial System* (XDD, August, 2004) which is included in Appendix B.

1.1 Purpose

The purpose of a 5-year review is to determine whether the remedy at a site is protective of human health and the environment. The methods, findings, and conclusions of reviews are documented in 5-year review reports. In addition, 5-year review reports make recommendations to correct any deficiencies found during the review, if any, and identify recommendations to address them.

1.2 Statutory Basis

This review is required by statute to be completed by August 28, 2005. USEPA requested that Carrier perform the review earlier due to plant expansion activities.

[1] Analytical and operations data through August 31, 2004 were included for both soil remediation systems, to designate all activities completed prior to Project Everest construction. Analytical and operations data through October 31, 2004 were included to represent interim action startup conditions at the Town of Collierville's Water Plant #2.

USEPA must implement 5-year reviews consistent with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). CERCLA, as amended, states:

If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented.

42 USC §9621(c), the National Contingency Plan, specifically Part 300.430 (f)(4)(ii) of the Code of Federal Regulations (CFR) states:

> If a remedial action is selected that results in any hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.

The remedy at the Collierville Site includes three remediation systems formalized as the final remedy in the USEPA's *Record of Decision* (ROD; USEPA, 1992) and subsequent design documents:

- Soil vapor extraction (SVE) in the main plant area (MPA), installed in 1995. The MPA system addresses soil impacted by trichloroethylene (TCE) releases in 1979 and 1985.

- SVE at the North Remediation System (NRS), installed in 1989. The NRS addresses TCE releases to the former sludge lagoon northwest of the manufacturing facility.

- Air stripping at the municipal water supply wells (the Town of Collierville's Water Plant #2 [WP#2]) immediately northwest of the facility, implemented in 1990. The WP#2 well field is used to contain contaminated groundwater migrating from the Site.

Treatment of soil and groundwater is ongoing, and hazardous substances are still present onsite at concentrations above levels protective of unrestricted use of the Carrier property.

1.3 Five-Year Review Report Format

The format for this review has been adapted from the USEPA *Comprehensive Five-Year Review Guidance* (June, 2001). Elements of the 5-year review are presented as outlined below:

- Section 2 presents a chronology of site events.
- Section 3 presents the site location information and the history of the Collierville Site, including a summary of the remedial investigation/feasibility study (RI/FS) and remedial design/remedial action (RD/RA).
- Section 4 discusses the remedial actions implemented at the Site, their performance, the Site inspection of each remediation system, and conclusions regarding remedy effectiveness.
- Section 5 documents the progress since the last 5-year review, including reviewing the protectiveness statement issued in 2000, reviewing implementation of recommendations from the 2000 review, and discussing Site changes which require remedy modifications.
- Section 6 describes the 5-year review process, including the administrative components of the 5-year review, community notification and involvement, document review, data review, the Site inspection, and interviews.

- Section 7 presents the technical review of the Site remedy using three questions:

  A. Is the remedy functioning as intended by the decision documents?

  B. Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of remedy selection still valid?

  C. Has any other information emerged that could call into question the protectiveness of the remedy?

- Section 8 identifies issues at the Site that could prevent the remedy from being protective.

- Section 9 identifies recommendations and follow-up actions for the Site remedy.

- Section 10 issues the protectiveness statement for the Carrier Collierville Site.

- Section 11 specifies the requirement for the next 5-year review.

2.0 SITE CHRONOLOGY

Table 2-1 is a chronology of Site events since development began on the Carrier property.

Table 2-1
Chronology of Events

Date	Event	Additional Information
1967	Town of Collierville purchased the property, constructed industrial buildings, and purchases industrial equipment for the Site.	
	Carrier leased the property, buildings and equipment for use as a manufacturing facility.	
	Town of Collierville installed two extraction wells at Water Plant #2 (WP#2) on the northwest corner of the Site to supply drinking water to residents.	
1972	Carrier installed wastewater lagoon (surface impoundment) north of plant.	Sometime between 1972 to 1979 the wastewater lagoon received trichloroethylene (TCE-) and zinc-contaminated waste, resulting in contamination of lagoon sediment.
1979	Carrier took wastewater lagoon out of service.	
	Spill of an estimated several thousand gallons of TCE occurs at a vent degreaser pipe just south of the main manufacturing building.	Carrier removed asphalt pavement and underlying soil from the parking area in areas affected by spill.
1981	Wastewater lagoon is closed.	Carrier removed approximately 1 foot of contaminated sludge from the base of the lagoon for offsite disposal.
1982	Lease amended to exclude northwest portion of property where Town's well are located.	
1985	Spill of approximately 500 gallons of TCE occurs from aboveground storage tank south of main manufacturing building.	Tank, associated piping, and up to 15 feet of contaminated soil was excavated and shipped offsite for disposal by Carrier.
	Carrier installed monitoring wells at the Site to monitor groundwater.	Groundwater monitoring at the Site continued on a regular basis.
1986	Tennessee Department of Environment and Conservation (TDEC) performed site assessment.	Low levels of TCE detected in the groundwater from the two extraction wells in WP#2. No TCE was found in treated water (i.e., water just before it enters the Town's distribution system) from the two extraction wells. As a result, under frequent monitoring, operation continued.
1987	On December 14, Carrier purchased all the property subject to the lease from the Town of Collierville.	Carrier is still the current land owner.
	Site is placed on TDEC's List of Hazardous Substances Sites.	
	Carrier initiated an extensive, voluntary site investigation under an agreement with TDEC through 1988.	Sampling indicated measurable concentrations of TCE in soil and lower concentrations in groundwater. Sampling confirmed TDEC finding of low TCE concentrations in WP#2 groundwater.

Table 2-1
Chronology of Events

Date	Event	Additional Information
1988	Voluntary site investigation report released to TDEC and the US Environmental Protection Agency (USEPA).	
	In June, the Site was proposed for inclusion on USEPA's National Priorities List (NPL).	
1989	In September, Carrier and USEPA signed Comprehensive Environmental Response and Liabilities Act (CERCLA) Consent Order.	Under this order, Carrier agreed to perform remedial investigations/feasibility studies (RI/FS) to determine the type and extent of contamination at the Site and identify remedial action alternatives.
	Carrier installed a groundwater removal and treatment system and soil vapor extraction (SVE) system in the former wastewater lagoon (the North Remediation System, NRS).	
1990	Placement of Site on NPL finalized.	
	Carrier commenced RI.	
	Draft RI report submitted to USEPA	
	Carrier installed air stripper treatment systems (packed aeration towers) at WP#2 to provide additional assurance of the removal of trace amounts of TCE and its degradation products from the Town's raw water supply. Design, construction, and operation of system was coordinated with and approved by State, Town of Collierville, and USEPA.	WP#2 remained in continuous service, providing up to 1.4 million gallons per day (MGD) of potable water to the Town of Collierville.
1992	The RI/FS Reports and Proposed Plan for the Site are finalized and released to the public.	The RI outlined findings and the FS identified the need for remediation in three areas: (1) former lagoon area (to address impact of former discharges to lagoon) (2) MPA (to address impacts from the 1979 and 1985 TCE spills) (3) Memphis Sand aquifer (to contain onsite groundwater plume that had been impacted as a result of soil contamination). Six remedial alternatives for the Site were also presented.
	USEPA Regional Administrator Greer C. Tidwell signed the Record of Decision (ROD) which documents the selected remedy for the Site.	Site remedy consisted of: • Institutional controls limiting future land use at the Site to industrial, and limiting water well construction in the area (restrict installation

Table 2-1
Chronology of Events

Date	Event	Additional Information
1992 (cont)		of wells which may adversely impact containment at WP#2). • Continuation of the NRS operations in the former lagoon area. • Installation of an SVE system in the MPA to treat contamination that resulted from the 1979 and 1985 spills . • Containment of the groundwater plume using the municipal well field at WP#2, with ongoing treatment of extracted groundwater via air stripping.
	Supplemental aquifer testing using the Town of Collierville's well field to support groundwater remedy design and to gauge the well field's adequacy to contain the contaminated Memphis Sand plume.	
1993	USEPA issued a Unilateral Administrative Order and Scope of Work for completion of remedial action tasks.	
1994	MPA SVE project design and groundwater remedy design documents were submitted.	
	Construction on the MPA SVE system was initiated.	The system was installed to treat contamination that resulted from the 1979 and 1985 spills.
	Installation of downgradient/point-of-compliance monitoring wells MW-60 and MW-62 occurred.	
1995	Main Plant Area (MPA) SVE system construction was completed with the system beginning operation during March 1995. Final inspection of the MPA SVE system was performed on June 1, 1995.	In February 1996, recurring problems with the regenerative blower used for the MPA system necessitated system shutdown in December followed by replacement with a positive displacement blower.
1996	Modifications to the MPA SVE system and testing of the new equipment were performed in February 1996, immediately followed by system re-start. Supplemental modeling of the degree of containment provided by WP#2 was performed in July and August 1996, during a month-long shut down of the Town wells for maintenance.	
	Soil borings were completed at the NRS to assess effectiveness of the NRS SVE system in December.	Improvements that were determined as a result of the assessment were addressed in 1997.

Table 2-1
Chronology of Events

Date	Event	Additional Information
1997	Based on the 1996 sampling event, modifications were made to NRS operation: deep wells (screened approximately 30 to 50 feet bgs) were opened to act as passive vents while vapor extraction was continued in shallow wells (screened at depths less than 25 feet bgs). During summer months, ambient air was also introduced into the shallow well manifold to moderate temperatures in the blower and minimize operational problems.	
	Carrier started abandonment of 55 monitoring and pilot study wells installed during the RI or RD investigation.	
1998	Abandonment of non-critical wells completed during the first quarter. All wells were closed in accordance with Shelby County Health Department regulations.	
	NRS blower failure, replacement with a positive displacement blower capable of generating higher vacuum. Tennessee Department of Transportation (TDOT) begins expansion of adjacent roadway; monitoring well MW-16 is in the construction area. Request to abandon MW-16 due to TDOT construction; subsequent abandonment of MW-16	
2000	Carrier's Collierville Site first Five-Year Review.	
2001	Modifications to WP#2 to accommodate higher flow rates from East and West Wells	
2002	NRS and MPA systems shut down pending repairs.	In concurrence with USEPA, repairs to both systems are deferred pending results of planned soil sampling activities.
	Soil sampling at NRS, MPA to assess progress of remediation system. Biased sampling results indicate concentrations at both areas still exceed the 533 µg/kg goal. System operations and equipment are reviewed for optimization.	
	Vision Project expansion at Carrier facility. Abandonment of MW-12 and MW-14.	100,000 square-foot expansion of the Carrier facility does not impact the Site remedy.
	Town of Collierville begins monitoring chromium at WP#2.	TDEC-Division of Water Supply requested that the Town initiate sampling for chromium due to the proximity of the Smalley-Piper Site and the potential for chromium plume migration into the well field.

Table 2-1
Chronology of Events

Date	Event	Additional Information
2003	Town of Collierville notifies Carrier that WP#2 was shut down for a 6-week period in March and April due to chromium concentrations.	Carrier submits a Notice of Potential for Delay in Performance of the Groundwater Remedy on May 8, 2003, discussing the shutdown and response actions implemented in support of the Town of Collierville
	Carrier begins monitoring chromium at WP#2 and supports the Town of Collierville with WP#2 modifications.	
	Carrier and the Town of Collierville identify flow rate modifications which may reduce the quantity of chromium in WP#2 finished water. Flow reduction tests were performed in October 2003.	Carrier submits a Notice of Potential for Delay in Performance of the Groundwater Remedy on October 30, 2003, discussing the flow rate modifications.
	Town of Collierville shuts down WP#2 due to increasing chromium concentrations.	Increasing chromium concentrations at WP#2 and issuance of the Agency for Toxic Diseases and Substance Registry's (ATSDR's) Health Consultation for the Smalley-Piper Site caused the Town to terminate operations of WP#2 despite its use for the Carrier groundwater remedy. Carrier submits a Notice of Potential for Delay in Performance of the Groundwater Remedy on December 10, 2003, discussing the shutdown and Carrier's schedule of activities.
	NRS restarted in December 2003. Optimization of system continues through March 2004.	
2004	A meeting with USEPA, TDEC-Division of Superfund (DSF), TDEC-Division of Water Supply (DWS), TDEC-Water Pollution Control (WPC), the Town of Collierville, and Carrier was held in Memphis, Tennessee, on January 29, 2004, to discuss possible options for restart of WP#2.	
	MPA restarted in April 2004 following equipment replacement and upgrade to accommodate excessive moisture and year-round operation.	Carrier obtains a sewer discharge permit from the Town of Collierville for treated water generated at the MPA.
	In anticipation of facility expansion activities, Carrier performs a soil sampling event in former TCE release areas identified in the RI.	
	Carrier works with USEPA, TDEC, and Town of Collierville to re-start WP#2. Carrier pursues short- and long-term operations options, including National Pollutant Discharge Elimination System (NPDES) discharge, potable discharge, chromium treatment, etc.	Schedule for Interim Actions at WP#2 is submitted to USEPA and TDEC on June 30, 2004.
	A meeting with USEPA, TDEC-DSF, and Carrier was held in Atlanta, Georgia, on July 22, 2004 to discuss the upcoming Project Everest facility expansion.	USEPA requests submittal of (a) a revised scope of work (SOW) to document changes associated with

Table 2-1
Chronology of Events

Date	Event	Additional Information
2004 (cont)		Project Everest, and (b) performance of the 5-year review.
	Carrier initiates Project Everest facility expansion. MPA system is abandoned to allow construction operations to proceed. MW-6 and MW-1B and MPE SVE wells are abandoned due to expansion activities.	SOW Addendum is submitted to USEPA on August 6, 2004.
	USEPA issues contingent approval for changes in remediation activities necessitated by Project Everest.	
	WP#2 restarted on October 29, 2004 for testing, with discharge to the Town of Collierville Publicly Owned Treatment Works (POTW). Continuous discharge resumed on November 8, 2004.	

3.0 SITE BACKGROUND

This location summarizes the Site's setting and history, including a summary of the RI/FS and RD/RA, and identifies the basis for taking action at the Site.

3.1 Physical Characteristics

The Site is on the western side of the Town of Collierville, Shelby County, Tennessee (population approximately 30,000). The Site, shown in Figure 3-1, is near the intersection of U.S. Highway 72 and Byhalia Road (note: all figures are included in Appendix A).

The Site is in the Gulf Coastal Plain, which is a major physiographic subdivision distinguished by gently rolling topography and a characteristically thick layer of loess deposited during Pleistocene glaciation. Because of the gently rolling topography, the Site has been graded and filled in various locations to change drainage patterns and adapt the land for manufacturing use.

Anomalous areas of loess deposition are associated with alluvial plains of Mississippi River tributaries that cross the area. These rivers include the Wolf River, the Loosahatchie River, and Nonconnah Creek. Nonconnah Creek is located south of Winchester Road, which is the southern boundary of the facility.

The nature of the Site is such that avian or terrestrial wildlife would not be drawn to the Site. Any wildlife near the Site is expected to be minimal, given the amount of development in the area. Since the impacted areas are within the working area of the manufacturing facility, wildlife is not expected to be present in impacted areas currently undergoing remedial actions.

3.2 Land and Resource Use

Prior to 1967, the Site consisted of maintained vegetation (i.e., grasses and trees). In 1967, the Town of Collierville purchased the property, constructed industrial buildings, and purchased industrial equipment for the Site. In March 1967, the property, buildings, and equipment were

leased to Carrier. Later the same year, Carrier began manufacturing residential heating and air conditioning units at the Site.

Also in 1967, the Town of Collierville installed a well field for potable water on the northwest corner of the Site. WP#2 operations consist of two extraction wells, a treatment plant, and a storage tank. Through December 2003, under frequent monitoring, the wells provided up to 1.4 million gallons per day (MGD) of potable water to the Town of Collierville.

In 1987, Carrier purchased the facility from the Town of Collierville, excluding the northwest parcel on which WP#2 sits.

With the current strict zoning, the long-term, future use of the Site would be for continued industrial use. The Site is an operating facility and will continue to be so for the foreseeable future.

With the exception of wet weather conveyances to Nonconnah Creek, and discontinuous, seasonal wetlands present in the wooded portion of the Site, surface waters do not exist onsite or adjacent to the Site. The Town of Collierville and county ordinances restrict the use of the perched water bearing zone and the Memphis Sand aquifer as a drinkable water sources. Perched groundwater is not currently used for domestic purposes in the immediate area. As stated above, the nearest known municipal wells tap the Memphis Sand aquifer and are located adjacent to the northwest corner of the Site (WP#2).

Current groundwater pathways exist for the local residents supplied by the Town of Collierville municipal water supply system.

3.3 History of Contamination and Response Actions

In the process of assembling air conditioning units, aluminum sheeting is stamped and assembled with copper tubing to form air heat exchangers. Stamping and forming oils and dirt

are removed from these parts prior to final assembly. Until about 1986, TCE was the primary solvent used to degrease and clean these parts.

Contamination Sources

In 1979 and 1985, TCE releases occurred from solvent storage systems to an area just south of the main manufacturing building. The 1979 release, which occurred from a vent degreaser pipe, was estimated to be several thousand gallons. In 1985, approximately 500 gallons of TCE were released from a pipe associated with an aboveground storage tank in the same vicinity. Soil removals were performed by Carrier following both spills.

In the rear of the facility, a wastewater lagoon operated by the plant from 1972 to 1979 apparently received TCE- and zinc-contaminated waste sometime during its 7-year operational period that resulted in contamination of lagoon sediment. Impacted sediment was removed from the lagoon prior to closure, and in 1989 a soil and groundwater treatment system (the NRS) was installed.

As a result of the 1985 spill, monitoring wells were installed at the facility to monitor groundwater. Since 1985, the Tennessee Department of Environmental Conservation (TDEC)[2] required groundwater monitoring on a regular basis. In 1986, low levels of TCE were detected in the groundwater from the two extraction wells in the Town of Collierville's WP#2. No TCE was found in treated water (i.e., water just before it enters the Town of Collierville's distribution system) from the two extraction wells. In 1990, air stripper treatment systems (packed aeration towers) were installed by Carrier at WP#2 to provide additional assurance that the Town of Collierville's drinking water supply would meet Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs).

In 1987 and 1988, under an agreement with TDEC, Carrier conducted an extensive site investigation. Sampling indicated measurable amounts of TCE in the soils and smaller amounts

[2] This agency was formerly known as Tennessee Department of Health and the Environment (TDHE).

in the groundwater at the Site. The site investigation also confirmed the earlier finding of low TCE concentrations in the groundwater from WP#2.

The Site was proposed for listing on the federal National Priorities List (NPL) in 1988. Carrier and USEPA signed a consent decree in 1989 to perform the RI/FS, and the Site was listed on the NPL in 1990.

Remedial Investigation

As a result of the spills, the USEPA ordered that an RI/FS be conducted to determine the extent of contamination from TCE source areas to groundwater, specifically perched groundwater. The RI was performed in multiple phases during 1990 and 1991, with draft RIs submitted throughout 1991 and a final document (including a Baseline Risk Assessment [BRA]) produced in 1992.

Previous investigations at the Site initiated by TDEC had resulted in the installation of 55 soil borings. Eighteen of these borings were completed as monitoring wells: 10 in the fluvial terrace deposits above the Jackson clay and 8 within the Memphis Sands aquifer beneath the Jackson clay layer. To complete the determination of extent of contamination, a series of 32 additional borings were augered onsite during the RI. Contaminants identified onsite were volatile organic compounds (VOCs), including TCE, cis-1,2-dichloroethylene (DCE), trans-1,2-DCE, tetrachloroethylene (PCE), and vinyl chloride, and zinc.

The RI verified the contaminants of concern at the site, identified both the MPA and the former lagoon as primary source areas, and calculated soil cleanup goals protective of groundwater. The BRA concluded that there were no risks to onsite workers due to ingestion or direct contact of exposed, contaminated soil.

Hydrogeologic Setting

The RI also included an assessment of the complex hydrogeologic setting of the Site. A shallow, non-potable aquifer (found in fluvial terrace deposits), usually only a few feet thick,

was found across the Site. The RI postulated that this zone is primarily perched groundwater. The Jackson clay, which has since been referred to as the "Jackson/Upper Claiborne formation," underlies fluvial deposits. Silts and clays typical of the Jackson/Upper Claiborne sequence were not encountered in borings completed south and east of the Carrier facility. Rather, surficial loess and fluvial deposits were deposited directly over the primary drinking water aquifer in the Memphis area, the Memphis Sand. These data indicated that the perched groundwater zone encountered beneath the MPA was hydraulically connected with unconfined portions of the Memphis Sand southeast and east of the Carrier facility. Groundwater in the Memphis Sand flows from the southeast, beneath the Carrier facility, and then to the northwest, to WP#2 where it is a confined aquifer.

Contaminants exceeding MCLs were quantified in both perched (fluvial deposit) and Memphis Sand wells during the RI. The RI postulated that contaminants had migrated from source areas along the top of clay "downslope" to the southeast where the absence of the Jackson/Upper Claiborne unit allowed direct infiltration of contaminants into the Memphis Sand. Aquifer testing during the RI indicated that municipal pumping at WP#2 controls groundwater flow beneath the Site, and confirmed that there was indeed hydraulic connection between the two units where clay was absent.

Baseline Risk Assessment

The BRA was conducted as a part of the RI/FS process to evaluate potential threats to human health and the environment from hazardous substances. BRAs are mandated by CERCLA (as amended by the Superfund Amendments and Reauthorization Act [SARA]) to assess the need for remedial action at NPL sites.

The BRA evaluated dermal contact pathways for Site soil, as well as ingestion/inhalation risks from onsite groundwater. Two land-use scenarios were considered: industrial use (the current and projected future use at the Site), and residential use (assumed under an "uncontrolled" setting).

The BRA concluded no significant direct inhalation exposure onsite would be expected as a large portion of the contaminated area is paved/covered. The unpaved areas of the Site are far less contaminated and are covered by maintained vegetation. Conservative estimates based on the total area of the Site, which has surface contamination, were used to assess current adult worker exposure to volatile contaminants of concern (COCs). The entire unpaved/uncovered area of the Site was used to assess the risk to adult workers posed by lead and zinc in the Site surface soils. In both instances, the workers were assumed to contact the Site uniformly.

To assess the risk posed to future site residents, the BRA evaluated exposures to children. To evaluate exposure to future child residents, it was assumed that the entire Site would be unpaved/uncovered and that all potential ingestion and dermal contact exposures would occur within the contaminated surface soil zones.

The results of the risk calculations for the major soil contaminants, using the above stated assumptions, are shown in Tables 3-1 and 3-2. Table 3-1 shows the potential risk to workers from the major contaminants of concern, and Table 3-2 shows the potential risk to future child residents. This data indicate that exposure to even the most contaminated surface soils does not pose an incremental lifetime cancer risk (ILCR) greater than the 1E-6 point of departure (one excess cancer death in a population of 1 million) for current site workers or future children onsite. Hazard indices (HI) were less than 1 for both scenarios, indicating no noncancer toxicity to site workers or potential residents.

Table 3-1
BRA Summary of Risks for Adult Workers from Oral and Dermal Exposure to Contaminants in Soil

Contaminant	Soil Contaminant Level (mg/kg)[a]	Upper Bound Risk Level[b]	Hazard Index
TCE	35	1.0E-7	—
1,2-DCE	0.077	—	7.2E-6
Vinyl Chloride	0	0[c]	—
DCA	0	0	—

Table 3-1
BRA Summary of Risks for Adult Workers from Oral and Dermal Exposure to Contaminants in Soil

Contaminant	Soil Contaminant Level (mg/kg)[a]	Upper Bound Risk Level[b]	Hazard Index
PCE [d]	0.011	1.5E-10	1.0E-6
Lead	12[e]	—	2.8E-2
Zinc	51[e]	—	2.3E-4
		Sum cancer risk = 1.0E-7	Sum HI = 0.028

Notes:

a = The 90-95 % upper confidence level was not calculated as the data are not normally distributed. The mean concentration was calculated for in all soils within surface contaminated areas. For metals the mean concentration was assumed to be in all unpaved/uncovered Site soils. TCE and 1,2-DCE concentrations are the means for all samples collected at depths of 0 to 5 feet, including screening data from Phase I.

b = Hazard Index (HI) of > 1 indicates potential non-cancer toxicity. The allowable risk range determined by USEPA is 1E-4 to 1E-6; risk within this range is considered on a case-by-case.

c = With these assumptions, approximately 89 mg/kg of vinyl chloride in soil at this Site would equal 1E-6 Incremental Lifetime Cancer Risk (ILCR) level.

d = PCE was identified in one soil sample.

e = Lead and zinc concentrations for all samples collected within 5 feet of ground surface were used to compute mean values.

Table 3-2
BRA Summary of Risks for Potential, Future Child Residents from Oral and Dermal Exposure to Contaminants in Soil

Contaminant	Soil Contaminant Level (mg/kg)[a]	Upper Bound Risk Level[b]	Hazard Index
TCE	35[d]	5.2E-7	—
1,2-DCE	0.077[d]	—	HI = 6.1E-6
Vinyl Chloride	0	0[c]	—
DCA	0	0	—
PCE	0.011	—	HI = 1.7E-6
Lead	12[e]	—	HI = 1.9E-1
Zinc	51[e]	—	HI = 3.9E-3
		Sum cancer risk = 5.2E-7	Sum HI = 0.19

Notes:

a = The mean concentration was calculated for all Site soil samples within 5 feet of ground surface where TCE and/or DCE has been identified; assumes 100% of Future Child Resident soil exposure is in contaminated area onsite.

b = Hazard Index (HI) of >1 indicates potential noncancer toxicity. Upper bound Incremental Lifetime Cancer Risk (ILCR) levels between 1E-4 and 1E-6 are considered on a case-by-case basis as to their acceptability level by the USEPA.

c = 1E-6 ILCR (with these assumptions) in soil ~150 µg/kg vinyl chloride.

d = TCE and 1,2-DCE data from samples collected prior to the initiation of the Remedial Investigation were included. Below detection limit results were not used in the calculation of means.

e = Lead and zinc concentrations for all samples collected within 5 feet of ground surface were used to compute mean values.

It was assumed that in the future the entire Site will be unpaved/uncovered. The perched water bearing water zone is not currently used as a source of drinkable water nor is it anticipated to be used as a drinkable source in the future. Therefore, it was not considered a viable future exposure pathway.

The most contaminated groundwater may pose a significant carcinogenic and noncarcinogenic risk if hypothetical, future residents were exposed. The ILCR to future residents posed by ingestion of groundwater is 2.5E-4. The HI values for lead and zinc were 4.1 and 0.82 respectively, under the future resident scenario.

The BRA for groundwater contamination resulted in risk ranges exceeding 1E-04. Given the proximity to WP#2 and the presence of Site contaminants in the municipal water supply, the BRA was evaluated using a residential drinking water scenario. However, treatment of groundwater prior to entry to the Town of Collierville's drinking water distribution system established at WP#2 during 1990 was noted to eliminate this risk and reduce contaminant concentrations to below SDWA MCLs.

Carrier performed an FS for the Site in 1992. The FS discussed six remedial alternatives for the Site. The need for remedial actions was identified in three areas: the former lagoon area, the MPA, and the Memphis Sand Aquifer. The document compared various remedies and treatment technologies for each of the three areas.

Record of Decision

USEPA issued the final ROD for the Site in September 1992, which documented the selected remedy for the Site that consisted of the following:

- Institutional controls limiting future land use at the Site to industrial, and limiting water well construction in the area which may adversely impact containment at WP#2.

- Continuation of the SVE system at the NRS (installed in the former lagoon area).

- Installation of an SVE system in the MPA.

- Containment of the groundwater plume using WP#2 wells, with ongoing treatment of extracted groundwater via air stripping.

Remedial design activities began at the Site in 1993. In 1996, Carrier and the Town of Collierville memorialized operations and maintenance (O&M) responsibilities for WP#2 and the air stripping towers installed in 1990. This agreement is included as Appendix C.

3.4 Basis for Taking Action

The RI/FS and the BRA identified TCE as the primary contaminant of concern at the Site, due to health risk associated with groundwater consumption. The air stripping towers installed at WP#2 removed TCE from the potable water supply prior to distribution, eliminating risk and allowing the Town of Collierville to continue using its existing supply and distribution network. Groundwater containment provided by operations at WP#2 prevented migration of the TCE plume.

Because no human health threat was quantified due to direct exposure to Site soil, cleanup criteria protective of groundwater were calculated. A TCE cleanup goal of 533 µg/kg in soil was calculated to be protective of the underlying Memphis Sand aquifer. Remedial actions at the MPA and NRS were designed to address onsite soil exceeding this criterion, to mitigate impacts to groundwater.

No other media (sediment or surface water) were impacted by Site contamination.

4.0 REMEDIAL ACTIONS

This section describes the operation of each remediation component of the Carrier Site remedy over the past 5 years. These components include:

- Institutional controls for land and groundwater use
- NRS SVE system
- MPA SVE system
- Point-of-use controls at WP#2
- Containment of contaminated groundwater using WP#2

All components were described in the 1992 ROD, and were designed and installed in accordance with the February 1993 Unilateral Administrative Order and Statement of Work.

4.1 Institutional Controls

Land use at the Collierville Site is zoned industrial. The Town of Collierville has indicated that long-range plans for the area anticipate land use will remain industrial/commercial.

Shelby County prohibits installation of drinking water wells within 0.5 miles of state or federal Superfund sites unless the well owner can demonstrate that the well will not enhance the migration of contaminants (Shelby County Well Construction Code, 4.01[C]).

4.2 North Remediation System

The NRS was installed in the former lagoon area during pre-CERCLA response actions in 1989, and has operated continuously since then, except as noted below.

4.2.1 Remedial Action Objectives

The RAO at the NRS is to prevent migration of contaminants in soil which would result in Memphis Sand aquifer contamination in excess of MCLs and applicable or relevant and appropriate requirements (ARARs). The 533 µg/kg TCE goal developed during the RI/FS and

selected as the ROD goal for remediation of the MPA spill area was deemed conservative and therefore was selected as the goal for the NRS.

4.2.2 Remedy Description

The NRS began operation in 1989 as a treatability study at the location of the former surface impoundment, north and west of the manufacturing buildings. Since the treatability test was successful as installed, operation was selected as the long-term Site remedy in this area.

Wells

Well configuration consists of an array of five 4-inch diameter stainless steel wells installed to recover contaminated, perched groundwater in the fluvial deposits and to allow vapor extraction from the unsaturated soil. The deep wells are screened from the top of the Jackson Clay through the lower 20 feet of the fluvial deposits (approximately 30 to 50 feet below ground surface [bgs]). Each well has 20 feet of 0.010-inch slot well screen attached to a riser completed to ground surface. Initially, the deep wells served as both SVE and perched groundwater extraction wells. Bottom-loading, pneumatic pumps delivered groundwater to a rectangular clarifier tank which overflows to one of two surge tanks. Perched groundwater extraction occurred during the initial phases of operation but has not been required since the early 1990s.

Within the deep well network is an arrangement of four 2-inch diameter stainless steel wells, screened in silty/clayey soil from 15 to 25 feet below ground surface. The shallow wells are constructed with a 10-foot section of 0.010-inch slot well screen attached to a section of stainless steel riser to ground surface. The shallow wells serve only as SVE wells.

Pumps

Bottom loading, pneumatic pumps were designed to deliver groundwater to a clarifier tank, which overflowed into one of two surge tanks. Pump construction was stainless steel and Teflon®. A 5-horsepower (hp) compressor at the equipment skid supplies air. Pump cycles are

actuated from control-panel mounted pneumatic timers. Well-head solenoids stopped air supply to pumps if a float switch did not sense a liquid level in the well. Water was piped underground from the well vaults to the treatment system through a manifold of polypropylene tubing contained within a 4-inch diameter polypropylene pipe.

Groundwater extraction occurred during the initial phases of operation, but has not been required since the early 1990s. The pumps were removed from the NRS in February 2004.

Air Stripper Columns

Water flowed by gravity from the clarifier into the first surge tank and is pumped to the top of a 12-inch diameter random packed stripping tower. One-inch diameter Jaeger Tripacks® were loaded to a bed height of 16 feet. A 2.5-hp blower provides countercurrent airflow in the packing section at 167 cubic feet per minute (cfm), while water is circulated through the packing at a design flow rate of 10 gallons per minute (gpm).

Air stripper columns and controls were decommissioned in October 2004.

Soil Vapor Extraction

Vapor recovery wells are connected to the central skid by a manifold of 2-inch polypropylene pipes. The deep and shallow wells are manifolded separately, and each well head has an isolation valve. The deep and shallow well piping connects at the surface where it was originally connected to a 5-hp, regenerative type air blower. This blower has since been replaced with a positive displacement blower capable of 180 cfm at 122 inches of water.

4.2.3 Remedy Implementation

The NRS system operated continuously from its installation and optimization in 1989 through 1998, when the original regenerative blower failed. The regenerative blower was replaced with a positive displacement blower. Vacuums generated at the wellhead ranged from 70 to 120 inches of water, the higher vacuums being generated when the shallow wells were stressed

by closing the deep well valve. The flow rate from the shallow wells averaged 25 to 30 cfm, and 100 to 110 cfm for the deep wells.

The system operated continuously from 1998 through 2001. Blower failure in October 2001 led to a system evaluation, including soil sampling which was documented in the *2002-2003 Annual Progress Report* (EnSafe, 2004). Elevated TCE concentrations were quantified in shallow silty/clayey soil, from 0 to 18 feet bgs; below this depth, in sand, TCE concentrations appeared to attenuate. Review of the system, equipment, and operations led to the following modifications, implemented in late 2003:

- The blower for the NRS was replaced.
- A larger moisture separator was installed.
- An hourmeter was installed.

Any water generated by the system is manually decanted from the moisture separator, and removed to the MPA for treatment and discharge into the sanitary sewer. Approximately 385 gallons were removed between November 2003 and May 2004; no significant moisture has been recovered since May. An additional 150 gallons of water were drained from the treatment system surge tanks in July 2004.

The system is currently being operated such that the majority of vapor removal is occurring through the upper, shallow wells (with terminal depths no deeper than 25 feet bgs).

4.2.4 System Performance

NRS operations are concentrated on shallow, silty/clay zone wells within 25 feet of ground surface.

During 2000 and 2001, the SVE system operated with both the shallow and deep well manifolds open, with more vacuum stress applied to the shallow wells. Table 4-1 shows operational data from the 2000/2001 operating seasons taken from the *Annual 2001 Progress Report*.

Table 4-1
NRS Operating Parameters 2000-2001

Depth	Quarter	Estimated Flow Rate (cfm)	Concentration (µg/L)	Mass Removal (lbs/Day)	Number of Days Operational	Total Mass Emitted (lbs)
Shallow	1Q00	20	2.17 [1]	0.0000	90	0.35
	2Q00	20	2.17	0.0000	91	0.35
	3Q00	20	302 [2]	0.0004	91	49
	4Q00	20	302	0.0004	91	49
	1Q01	20	1,460	0.0018	90	240
	2Q01	20	2.37 [3]	0.0000	91	0.39
	3Q01	20	216 [4]	0.0003	91	35
	4Q01	20	216 [5]	0.0003	31	12
Deep	1Q00	180	1.26 [1]	0.0000	90	1.8
	2Q00	180	1.26	0.0000	91	1.9
	3Q00	180	9.92 [2]	0.0001	91	15
	4Q00	180	9.92	0.0001	91	15
	1Q01	180	97.1	0.0011	90	140
	2Q01	180	6.19 [3]	0.0001	91	9.1
	3Q01	180	11.1 [4]	0.0001	91	16
	4Q01	180	11.1 [5]	0.0001	31	5.6

Notes:
[1] = Data were taken from June 2000 sampling event.
[2] = Data were taken from November 2000 sampling event.
[3] = Data were taken from February 2001 sampling event.
[4] = Data were taken from May 2001 sampling event.
[5] = Data were taken from May 2001 sampling event.
NRS = North Remediation System
cfm = cubic feet per minute
µg/L = micrograms per liter
lbs/day = pounds per day
lbs = pounds
All data taken from the *2001 Annual Report*

Since the system was restarted in November 2003 and optimized during the first quarter of 2004, operations have focused on additional mass removal from shallow soil. Vacuum pressures are currently 80 to 90 inches of water. Operations data for 2004 through October 31, 2004 are shown in Table 4-2, following completion of optimization activities. Backup data for mass removal calculations are included as Appendix D.

Table 4-2
NRS Operating Parameters 2004

Depth	Date	Air Velocity (LFM)	Flow Rate (m^3/min)	Concentration (µg/m^3)	Mass Removal (Lbs./Day)	Elapsed Days of Operation	Total Mass Removed (lbs)
Shallow	3/11/2004	2139	1.32	2,323	2.93	0	0
	4/22/2004	2720	1.68	580	2.45	42	103
	5/5/2004	2825	1.75	103	1.77	13	23
	6/1/2004	2288	1.41	190	1.39	27	38
	7/1/2004	2587	1.60	843	0.37	30	11
	8/4/04	5342	3.30	370,000	3.89	34	132
	9/13/04	5370	3.32	370,000 *	3.89	40	156
	10/28/04	5388	3.33	22,200	0.23	45	11

Notes:
NRS = North Remediation System
lfm = linear feet per minute
m^3/min = cubic meters per minute
µg/m^3 = micrograms per cubic meter
lbs/day = pounds per day
lbs = pounds
* = Concentration assumed to be consistent with prior sampling event.
Operations data provided by SAS Environmental.
To convert m^3/min to cfm, multiply by 35.31. For example, (1.32 m^3/min)(35.31) = 46.6 cfm
To convert µg/m^3 to µg/L, multiply by 1E-03. For example, (2,323 µg/m^3)(1E-03) = 2.3 µg/L

Operation of the NRS SVE system has resulted in continued removal of TCE soil contamination from soil identified during the RI. Annual removal data are shown in Table 4-3. Based on system discharge data, 12,460 lbs of TCE have been removed by vapor extraction since January 1992.

Table 4-3
Annual Removal Data — NRS

Year	Mass Removed (lbs)
1989 through 1995	11,035
1996 through 1999	391
2000	232
2001	193
2002	System Evaluation/Shutdown
2003	78
2004 (thru October 31)	531

Notes:
NRS = North Remediation System
lbs = pounds

4.2.5 O&M Requirements/Summary

NRS systems are checked weekly. Standard O&M includes the following:

- Inspect system.
- Check belts; replace as needed.
- Grease blowers weekly.
- Change oil and clean particulate filters monthly.
- Sample vapor monthly.
- Measure contents of moisture separator, and if necessary decant water into drums for transportation to the MPA for treatment.[3]
- Record operating parameters.
    - Total VOC concentrations (in parts per million [ppm], using a photoionization detector [PID])
    - Operating vacuums (inches water column or inches of mercury, using both hand-held manometers and system gauges)
    - Air velocity (linear feet per minute [lfm], using a hand-held meter)

4.3 Main Plant Area

The MPA system was installed during 1994 and 1995 and operational continuously since startup, except as noted below.

[3] During the MPA reconstruction process, any water generated at the NRS will be drummed, characterized, and disposed offsite as determined by analytical results.

4.3.1 Remedial Action Objectives

The RAO at the MPA is to prevent migration of contaminants in soil which would result in Memphis Sand aquifer contamination in excess of MCLs and ARARs. The target levels for soil cleanup to prevent soil-to-groundwater transfers is 533 µg/kg TCE.

4.3.2 Remedy Description

The SVE system installed in the MPA area was more complex than that installed at the NRS. Its components are described below. As discussed in more detail in Section 5, the MPA was decommissioned due to the Project Everest expansion activities in August 2004.

Wells

The MPA SVE system consisted of six shallow (depth to 20 feet bgs) wells, one deep (depth to 40 feet bgs) well, and two horizontal extraction wells (depth 2 to 3 feet bgs).

Each vertical SVE well was constructed of 2-inch schedule (SCH) 40 polyvinyl chloride (PVC) piping, with 15-feet of 0.010-inch slotted well screen and riser pipe. The horizontal wells, which ran the length of the building from the breezeway east to the edge of the concrete cover, were also constructed of 0.010-inch slotted well screen. Shallow and deep SVE wells were manifolded separately to the equipment compound, where each manifold was fitted with a 4-inch valve for operation. The horizontal wells were also separately manifolded to the equipment compound and contain 4-inch valves for independent operation. The horizontal wells also contained 1-inch valves, which could be open to the atmosphere to serve as a passive air inlet when not being used for extraction.

Moisture Separator

The original design for the MPA required that extracted soil vapors first pass through a 40-gallon moisture separator to remove entrained water vapor from the airstream before it passes through the carbon vessels and the vacuum blower. A high-level float switch shut down the system when the separator was full. A drain was manually opened to remove this water

from the separator into drums. Drums were managed as hazardous waste and disposed of offsite using a hazardous waste management firm.

In-Line Flowmeter

Soil vapor passed through a 4-inch flowmeter. The flowmeter was calibrated to read airflow rate from 10 to 100 cfm. Individual line or well flow could be measured by opening/closing the appropriate manifold valve.

In-Line Heater

Before entering the carbon vessels, soil vapor passed through the in-line heater to diminish the negative effect of relative humidity on carbon adsorption capacity. The heater was operational when the main heater control was on and air was passing through the duct. The heater automatically shuts down by operation of an airflow switch when no air was passing through the duct. A temperature indicator downstream of the heater was used to monitor air inlet temperature into the carbon vessels.

Gas-Phase Carbon Adsorbers

Soil vapor was directed to two skid-mounted gas-phase carbon adsorbers. Each adsorber holds 2,000 pounds of 4 x 10 mesh size reactivated carbon, and had 6-inch inner diameter (ID) inlet and outlet flanges and manways for removal/addition of carbon. Vacuum gauges located upstream, between, and downstream of the carbon units are used to monitor pressure drops across the adsorbers.

In-Line Air Filter

The soil vapor passed through a high-efficiency particulate air filter to remove fine-particle solids from the airstream. Pressure gauges located upstream and downstream of the unit were used to monitor the pressure drop across the filter.

Vacuum Relief Valve

The vacuum relief valve was installed to prevent excessive system vacuum. The valve was set to release when line pressure just upstream of the vacuum blower exceeds 170 inches of water.

Air Intake Valve

A provision for dilution air was provided through a filtered intake at the blower. A gate valve was positioned to regulate the amount of make-up air that was fed into the system. Make-up air was necessary for starting the vacuum system under no-load conditions and for operating the system at variable levels of vacuum and vapor flow.

Vacuum Blower

The vacuum blower originally in operation at the MPA was a regenerative pump capable of providing at least 384 cfm under no-load conditions and capable of operating up to a vacuum of 174 inches of water or 163 inches of water during continuous operation. However, this blower failed on two occasions and was sent back to the manufacturer. The cause, as determined by the manufacturer, was ingestion of foreign material causing the blower to lock (probably very fine soil particulates). After the second failure, the blower was replaced with a 5-hp, positive displacement blower capable of providing 125 cfm at 41 inches of water, or 50 cfm at 190 inches of water.

A high-level signal from the liquid level sensor in the moisture separator shut down the vacuum blower. A temperature indicator on the discharge piping allowed monitoring of the physical conditions of the air discharge stream.

Process Instrumentation and Control

The SVE system could be operated on a timer. Various points in the process were monitored and could actuate a system shutdown, including the following:

- High water levels in the moisture separator
- Excessive pressure upstream of the vacuum blower

4.3.3 Remedy Implementation

Following startup in 1995, the MPA experienced recurring problems with the regenerative blower. The system was shut down and modified in December 1995 and a positive displacement blower installed; system performance was acceptable following restart in February 1996. Operations indicated that entrained moisture recovered in the moisture separator was significant, and wet season operations typically incurred multiple shutdowns per week due to high water levels. Review and analysis of the system and moisture separator operations suggested that:

- The MPA system should be operated during dry seasons (e.g., June through October).
- Operations into the rainy season could be managed through bi-weekly checks on water levels in the moisture separator.
- Daily checks were required during rainfall events, or the system was shut down until dry weather resumed.

This operational approach was maintained from 1996 through 2001.

Following failure of the moisture separator in January 2002, a system evaluation was performed, including soil sampling which was documented in the *2002-2003 Annual Progress Report*. Elevated TCE concentrations were quantified in shallow silty/clayey soil, from 0 to 15 feet bgs; below this depth, TCE concentrations appeared to attenuate. Review of the system, equipment, and operations led to the following modifications, implemented in early 2004:

- A larger moisture separator was installed.

- Aqueous phase granular activated carbon was installed to treat any entrained moisture collected in the separator.

- A totalizing flowmeter was installed to record the volume of entrained moisture treated in the system.

- A sewer discharge permit and direct connection with the Town of Collierville's sanitary sewer was obtained to manage entrained moisture.

- The treatment pad was enclosed, to prevent freeze/thaw problems.

- A remote monitoring system was installed with cellular telemetry to monitor system operations.

Following restart, the system was operated with shallow, deep, and horizontal manifolds partially open. Manifolds were adjusted to regulate airflow from the three intervals and to maximize VOC concentrations in system influent.

4.3.4 System Performance

During 2000 and 2001, the SVE system operated with both the shallow and deep well manifolds open. Table 4-4 shows operational data from the 2000/2001 operating seasons, taken from the *Annual 2001 Progress Report.*

Table 4-4
MPA Operating Parameters 2000-2001

Depth	Quarter	Estimated Flow Rate (cfm)	Concentration (µg/L)	Mass Removal (lbs/Day)	Number of Days Operational	Total Mass Emitted (lbs)
Shallow	1Q00	25	856	1.92	57	109
	2Q00	25	856	1.92	38	73
	3Q00	25	600	1.34	59	79
	4Q00	25	1170	2.62	51	134
	1Q01	25	403 [1]	0.90	43	39
	2Q01	25	159 [1] [2]	0.36	91	32
	3Q01	25	1014 [2] [3]	2.27	91	207
	4Q01	25	625 [1]	1.40	61	85
Deep	1Q00	45	1042	4.20	43 [4]	239
	2Q00	45	1042	4.20	91 [4]	160
	3Q00	45	248	1.00	91 [4]	59
	4Q00	45	248	1.00	61 [4]	51
	1Q01	45	311	1.25	43	54
	2Q01	45	750	3.03	91	275
	3Q01	45	1002	4.04	91	368
	4Q01	45	1002	4.04	61	247

Notes:
[1] = Combined influent data; shallow manifold samples not available.
[2] = From February 2001.
[3] = From May 2001.
[4] = Deep manifold operating duration assumed to be the same as the shallow manifold.
MPA = Main Plant Area
cfm = cubic feet per minute
µg/L = micrograms per liter
lbs/day = pounds per day
lbs = pounds
Data obtained from the *2001 Annual Progress Report*

Since the system was restarted in April 2004 and optimized during the second quarter of 2004, operations have focused on additional mass removal from shallow soil. Vacuum pressures were approximately 35 inches of water column, 75 to 80 cfm. Operations data for 2004 are shown in Table 4-5, following completion of optimization activities. The system was shut down on August 19, 2004, due to a facility expansion project (Project Everest); system replacement is discussed in Section 5. Annual mass removal is summarized in Table 4-6. Backup data for mass removal calculations are included in Appendix D. Since 1995, approximately 3,916 lbs of TCE have been removed by the system.

Table 4-5
MPA Operating Parameters 2004

Date	Air Flow (cfm)	Flow Rate (m^3/min)	Concentration (µg/m^3)	Mass Removal (Lbs./Day)	Elapsed Days of Operation	Total Mass Removed (lbs)
5/5/2004	80	2.27	7.3	0.05	8	0.4
6/1/2004	75	2.12	190	0.30	27	7.8
7/1/2004	78	2.21	73	0.53	30	16.2
8/4/2004	72	2.04	28,000	0.18	30	6.2
8/19/04	68	1.93	28,000 *	0.17	15	2.6

Notes:
MPA = Main Plant Area
cfm = cubic feet per minute
m^3/min = cubic meters per minute
µg/m^3 = microgram per cubic meter
lbs/day = pounds per day
lbs = pounds
* = Concentration assumed to be consistent with prior sampling event.
Operations data provided by SAS Environmental.
To convert m^3/min to cFm, multiply by 35.31. For example (2.27 m^3/min) (35.31) = 80.1 cFm
To convert µg/L, multiply by 1E-03. For example (28,000 µg/m^3) (1E-G3) = 28 µg/L

Table 4-6
Annual Mass Removal — MPA

Year	Mass Removed (lbs)
1995	1,539
1996	179
1997	314
1998	44
1999	472
2000	348
2001	987
2002/2003	System Evaluation/Shutdown
2004	33

Notes:
MPA = Main Plant Area
lbs = pounds

Water Recovery

System improvements completed in 2004 included installation of a larger moisture separator and granular activated carbon for treatment of aqueous phase contaminants. Since system startup in April 2004, approximately 4,800 gallons of entrained moisture have been recovered, treated, and discharged to the Town of Collierville's sanitary sewer system.

Shallow Groundwater Concentrations

MW-31 was used as an indicator well to measure eventual effectiveness of the soil remediation system in place at the MPA. MW-31 was installed at a depth of 50 feet bgs. The Jackson/Upper Claiborne was absent at this location, indicating the confining unit "pinches out" to the northwest of MW-31. The top of clay contours of the Jackson Clay indicate it slopes radially with a prominent downgradient direction toward the east-southeast (toward MW-31) and to the west. Therefore, contaminants entering the shallow groundwater near the main plant would migrate in a direction toward MW-31.

TCE concentrations from the quarterly groundwater data for MW-31 indicated an overall downward trend from a high of 1,100 µg/L in 1991, but remain above the clean-up goal of 5 µg/L. It is not clear if this well was intended to be a groundwater compliance point, and its purpose will be evaluated in the near future. Results of the quarterly sampling are shown in Table 4-7. MW-31 was destroyed during the Tennessee Department of Transportation (TDOT) road construction activities in 2000. Records indicate that the well was buried under approximately 3 feet of fill material.

MW-31 was not replaced following the TDOT construction activities of 2000. Both USEPA and TDEC have expressed concerns about not replacing the monitoring well in this portion of the site, to monitor changes in TCE concentration and to assess historically elevated levels of lead and zinc described in the *2000 Five Year Review*. Carrier will evaluate the existing data from MW-31 and adjacent wells to determine possible methods of addressing the concerns in the near future.

Table 4-7
Historical MW-31 Concentrations

Sampling Event	TCE (µg/L)
RI/FS	
8/15/90	170
11/16/90	980
2/21/91	1,100
4/24/91	230
8/21/91	55
11/13/91	288

Table 4-7
Historical MW-31 Concentrations

Sampling Event	TCE (µg/L)
RD/RA	
3rd Quarter 1995	53
4th Quarter 1995	140
1st Quarter 1996	170
2nd Quarter 1996	19
3rd Quarter 1996	67
4th Quarter 1996	110
1st Quarter 1997	65
2nd Quarter 1997	25
3rd Quarter 1997	21
4th Quarter 1997	65
1st Quarter 1998	Not sampled
2nd Quarter 1998	14
3rd Quarter 1998	52
4th Quarter 1998	Well damaged by TDOT, pending repairs
1st Quarter 1999	Well damaged by TDOT, pending repairs
2nd Quarter 1999	19
3rd Quarter 1999	45
4th Quarter 1999	80
1st Quarter 2000	82
2nd Quarter 2000	250

Note:
µg/L = micrograms per liter
* = Duplicate sample analyzed using alternate methodology, see RI for details

4.3.5 O&M Requirements/Summary

MPA systems were checked weekly following system startup in April 2004. Standard O&M included the following:

- Inspect system.
- Check belts; replace as needed.
- Grease blowers weekly.
- Change oil and clean particulate filters monthly.
- Sample vapor monthly (influent, between carbon vessels, and effluent).

- Sample moisture separator contents weekly per Town of Collierville discharge permit.
  - Influent — VOCs
  - Effluent — VOCs, biological oxygen demand, total suspended solids, chromium, pH, and dissolved oxygen

- Record operating parameters.
  - Total VOC concentrations (in ppm, using a PID)
  - Operating vacuums (inches water column or inches of mercury, using both hand-held manometers and system gauges)
  - Airflow (in cfm, using a hand-held meter and system gauges)
  - Sewer discharge volumes (instantaneous and total, from totalizer)

Remediation-related wastes shipped offsite during the 2000 through 2004 period are summarized in Table 4-8.

Table 4-8
Remediation Wastes Shipped Offsite 2000 through 2004

Date	Waste Type	Volume (Weight)	Destination
8/22/00	Spent carbon from MPA	17 drums (5,096 lbs)	Ensco, El Dorado, AR
7/31/01	Entrained water from MPA	6 drums (2,326 lbs)	Ensco, El Dorado, AR
1/4/02	Spent carbon from MPA	16 drums (3,280 lbs)	Ensco, El Dorado, AR
1/22/02	Entrained water from MPA	4 drums (5,245 lbs)	Ensco, El Dorado, AR
4/19/02	Soil IDW from drilling/sampling	1 drum (358 lbs)	Ensco, El Dorado, AR
7/8/02	Soil IDW from drilling/sampling	1 drum (306 lbs)	Ensco, El Dorado, AR
5/26/04	Soil IDW from drilling/sampling	1 drum (121 lbs)	Spring Grove Resource Recovery, Cincinnati, OH
8/2/04	Spent carbon from MPA	15 drums (5,105 lbs)	Spring Grove Resource Recovery, Cincinnati, OH
8/26/04	Spent carbon from MPA decommissioning	16 drums (5,600 lbs)	Spring Grove Resource Recovery, Cincinnati, OH

Note:
lbs = pounds

4.4 Groundwater Treatment System (WP#2)

The groundwater treatment system at WP#2 was installed during 1990 to remove TCE from groundwater before it enters the municipal water supply. It has been operating continuously since installation, except as noted below.

4.4.1 Remedial Action Objectives

The goal of the remedial action is to contain TCE-contaminated groundwater onsite, until cleanup levels for the contaminants of concern are reached throughout the attainment area (e.g., the plume boundary). Cleanup goals for the Site, as established by USEPA and presented in the ROD, are shown in Table 4-9.

Table 4-9
Groundwater Cleanup Levels

Contaminant	Goal (µg/L)
Trichloroethylene	5
Cis-1,2-Dichloroethylene	70
Trans-1,2-Dichloroethylene	100
Tetrachloroethylene	5
Vinyl Chloride	2
Lead	15
Zinc	5,000

Note:
µg/L = micrograms per liter

4.4.2 Remedy Description

In 1990, Carrier and the Town of Collierville designed and installed an air-stripping tower system at WP#2 to treat contaminated groundwater that had reached the Memphis Sand aquifer. This 1.5 MGD system removed TCE from raw water before it entered the chlorination system and allowed the town to use WP#2. The treatment system was designed to handle incoming TCE concentrations of up to 300 µg/L. Parameters included for design were based on the operation of one air stripper and are summarized in Table 4-10.

Wells/Pumps

Groundwater was pumped from the two Town of Collierville wells, each of which uses a 20-hp, vertical turbine pump rated at 500 gpm. Conditions that stopped these pumps included air stripper blower pressure drops below 0.5 inches of water column (indicating blower failure), water in the air stripper sump exceeds 40 inches, or high water levels in the WP#2 above-ground storage tank.

Table 4-10
Design Parameters for Each WP#2 Air Stripper

Influent Concentration	300 µg/L TCE
Effluent Concentration	≤ 1 µg/L TCE
Liquid Flow	500 gpm (each)
Air Flow	4,500 cfm
Temperature	≥ 50 degrees Fahrenheit
Packing Material	3.5-inch diameter Jaeger Tri-Pack®
Tower Height	29 feet
Tower Diameter	5 feet

Notes:
µg/L = micrograms per liter
TCE = trichloroethylene
gpm = gallons per minute
cfm = cubic feet per minute

Treatment

Once groundwater was pumped from the wells, it was routed to a 10-inch diameter combined influent header, which split the flow to the two air strippers, depending upon whether both well pumps are running or just one. If both pumps were operating, the combined flow was split between the two air strippers; otherwise, flow was directed to only one air stripper. Once pumped water reached the top of each stripping tower, it entered a distributor to disperse the water over the entire surface area of the packing medium (3.5-inch Jaeger tripacks). The water then gravity flowed through the packing as air blows in through the bottom of each tower, creating a mass transfer of contaminants from a liquid phase to a gaseous phase where it discharged through the top of the air strippers.

Treated water was pumped underground to the original water plant equipment. While being injected with chlorine, water was gravity fed from the aeration tower to a 300,000-gallon ground storage tank. Finally, two 800-gpm service pumps transferred the final treated water to the distribution system.

4.4.3 Remedy Implementation

The groundwater treatment system at WP#2 was installed during 1990 to remove TCE from groundwater before it entered the municipal distribution system. The treatment system has operated continuously since installation and has met all remedial goals. System modifications were implemented in 2002 and 2003.

System Enhancements – 2002

In 2001, TCE was quantified in WP#2 effluent at concentrations below the MCL. The cause of increasing effluent concentrations was attributed to the Town of Collierville's maintenance of the well pumps, which resulted in higher water flow rates through the air stripping towers, and siltation of the distributors from well redevelopment.

Several maintenance tasks were completed during the first half of 2002 to improve removal efficiencies, including the following replacements:

- Lateral distributors at the top of the air stripping towers to ensure even distribution of water across the entire tower diameters.
- The top 1 foot of packing media with 3.5-inch Lanpac (manufactured by Lantec) which more evenly distributes flow.
- New 10-hp motors with resulting increases in air flow rates to 5,000 cfm per tower.
- New air intake screens with larger, 16-square-foot screens for improved air flow.

Performance data from 2002 indicated that these maintenance activities improved treatment efficiencies: TCE was no longer detected in air striper effluent.

Control Modifications — 2003

As discussed in the *2002-2003 Annual Progress Report*, Carrier was notified of the presence of chromium in the WP#2 well field in April 2003. The chromium is from an offsite source, believed to be the Smalley-Piper Site in Collierville (USEPA ID#TNN000407378), which historically performed chromium plating operations and exhibited chromium contamination in groundwater in 1990.

Due to concerns about chromium migration from the Smalley-Piper Site into the WP#2 well field, the TDEC's Division of Water Supply (DWS) requested that the Town of Collierville monitor chromium concentrations from the well field quarterly; sampling frequencies were increased to monthly at the beginning of 2003. Due to increasing chromium concentrations, WP#2 was shut down temporarily in March 2003, at which time Carrier was notified of the chromium plume and its impact on WP#2; a copy of this correspondence is included in Appendix E. At the time, discussions between the Town and TDEC-DWS proposed termination of operations at WP#2 when water from the West Well reached 80% of the chromium MCL (100 µg/L) or 80 µg/L. In March 2003, Collierville elected to stop pumping in advance of that condition; chromium concentrations in the West Well had increased to 65 µg/L.

Following the March shutdown, Carrier worked with the Town of Collierville to ensure that West Well would not operate without significant dilution capacity provided by East Well (which has typically exhibited lower chromium concentrations, between 5 and 20 µg/L). Carrier provided control modifications at WP#2 that achieved the following:

- East Well and West Well started pumping at the same time.
- In the event that the pump in East Well failed, pumping from the West Well would be terminated immediately.

Concurrently, Carrier and the Town of Collierville performed additional sampling to confirm that chromium was present at WP#2 primarily in the more mobile hexavalent form.

Following implementation of control modifications at WP#2 in April 2003, the facility operated as designed through December 2003. During this period, the Agency for Toxic Substances and Disease Registry (ATSDR) issued a Health Consultation establishing a screening level of 30 µg/L for hexavalent chromium (Tennessee Department of Health, 2003, October); this document is included as Appendix F. Chromium concentrations at WP#2 had continued to rise, and finished water concentrations in October 2003 were higher than 30 µg/L. Carrier and the Town of Collierville implemented a short-term test to determine whether modulating flow rates could reduce chromium concentrations in finished water to less than the screening level. Preliminary data indicated this was possible; however, the Town of Collierville experienced operational difficulties (associated with balancing flow rates from the storage tank and high service pumps) and terminated the test. Correspondence regarding the flow rate modifications is included as Appendix G.

Carrier was informed verbally on Wednesday, December 3, 2003, that the Town of Collierville had shut down WP#2. According to Tim Overly, Collierville Public Works Director, the well was shut down because the administration of the Town of Collierville did not want to distribute finished water with any detectable levels of hexavalent chromium. As stated in Section 2, Carrier provided written notification of the shutdown to USEPA on December 10, 2004; this notice is included as Appendix H.

Carrier hosted a large meeting with representatives from USEPA, TDEC-Division of Superfund (DSF), TDEC-DWS, TDEC-Water Pollution Control (WPC), and the Town of Collierville on January 29, 2004, and identified multiple options for restart of WP#2, including discharge to the Town's publicly owned treatment works (POTW), reuse for potable supply, and discharge to surface water via National Pollutant Discharge Elimination System (NPDES) permit. Both interim and long-term operations were discussed. USEPA and TDEC personnel participated in multiple subsequent conference calls regarding the shutdown of WP#2 and reuse/permitting

concerns. In June 2004 Carrier submitted a *Schedule for Interim Actions at Water Plant #2* (EnSafe, 2004, June 30) which included the following plans to re-start WP#2:

- Construction of discharge piping from WP#2 to the Town of Collierville's sanitary sewer.
- Operation of WP#2 for 6 months at a flow rate of 500 gpm to gauge chromium concentration trends in the West Well.
- Pilot testing of chromium treatment technologies.
- Pursuit of long-term discharge options, including both potable use in the Town of Collierville's distribution system and potential discharge to Nonconnah Creek via NPDES-permitted discharge.

This document is included as Appendix I.

WP#2 was re-started for testing purposes on October 29, 2004, and resumed continuous operation on November 8, 2004; Carrier's notification to USEPA is included as Appendix J. As outlined in the *Schedule for Interim Actions at Water Plant #2*, the West Well pumps continuously at a rate of 500 gpm. Groundwater is treated for VOCs using the existing air strippers, and then discharged to the POTW through a sanitary sewer connection behind the Carrier facility (Permit No. TOC006, effective July 1, 2004). No storage occurs in the Town of Collierville's aboveground storage tank, and no chlorination/fluoridation occurs. A pressure switch is used to monitor discharge line conditions, and will terminate operations if a sudden pressure drop occurs (suggesting a breach in the discharge line). Carrier's agreement with the Town of Collierville governing the interim actions at WP#2 is included as Appendix K.

4.4.4 TCE Performance to Date

Contaminant concentrations in the Town of Collierville wells have been monitored since June of 1990. Data from the 2000 through 2003 period are shown in Table 4-11.

Table 4-11
TCE Concentrations at WP#2 — 2000 through 2004 (µg/L)

Quarter	East Well	West Well	After Stripper
1Q00	82	150	2
2Q00	NS	180	2
3Q00	76	150	2
4Q00	91	130	2
1Q01	100	100	1
2Q01	69	92	3
3Q01	110 D	180 D	2.6
4Q01	130 D	190 D	3.1
1Q02	95	220	ND
2Q02	99	140	ND
3Q02	120	160	ND
4Q02	140	140	ND
1Q03	160	160 J	ND
2Q03	170	110	0.35 J
3Q03	170	130	0.14 J
4Q03	Wells shut down due to chromium problem.		
1Q04	Wells shut down due to chromium problem.		
2Q04	Wells shut down due to chromium problem.		

Notes:
NS = Not sampled due to well maintenance activity.
ND = Not detected above method reporting limit of 1 µg/L.
µg/L = micrograms per liter
D = Concentration obtained from a diluted sample
J = Concentration estimated.

Since quarterly monitoring began in 1995, TCE has been the primary constituent detected in the Collierville wells; other than trace concentrations of 1,2-DCE, no other chlorinated VOCs have been detected above the method detection limit.

Lead has not been detected in either the East or the West Well at concentrations above 15 µg/L, and analytical results typically indicate that it is not detected above method reporting limits of 2 to 3 µg/L. Zinc concentrations are also typically very low, less than 50 µg/L, with occasional detections of up to 310 µg/L.

Mass Removal

Mass removed by WP#2 is calculated from influent concentrations from the Town of Collierville wells, the combined flow from the wells, and the assumption that the air stripper removes 100% of TCE from the influent groundwater. Based on these assumptions, WP#2 has removed

5,222 pounds of TCE since the system was installed. Table 4-12 shows the pounds of TCE removed per quarter. Backup data for mass removal calculations are included in Appendix D.

Table 4-12
WP#2 Mass Removal Data — 2000 through 2004

Quarter	Flow Rate (gal)	Mass Removed (lbs)	Cumulative Mass Removed (lbs)
Pre-2000			3,632
1Q00	92,583,000	89	3,721
2Q00	89,544,000	60	3,781
3Q00	104,183,000	104	3,885
4Q00	101,881,000	101	3,986
1Q01	91,804,000	68	4,054
2Q01	105,499,000	76	4,130
3Q01	107,318,000	109	4,239
4Q01	99,030,000	110	4,349
1Q02	88,000,000	112	4,461
2Q02	96,960,000	118	4,579
3Q02	106,307,000	124	4,703
4Q02	97,215,000	109	4,812
1Q03	80,215,000	98	4,910
2Q03	83,980,000	103	5,013
3Q03	103,699,000	130	5,143
4Q03	63,277,000	79	5,222
1Q04	System shut down due to chromium problems.		5,222
2Q04	System shut down due to chromium problems.		5,222
3Q04	System shut down due to chromium problems.		5,222

Notes:
gal = gallons
lbs = pounds

4.4.5 O&M Evaluation

Very little maintenance is required of the air strippers and associated equipment, but under an agreement with Carrier, maintenance of the wells, pumps, and distribution system is the responsibility of the Town of Collierville Public Works Department.

The Town of Collierville checks the well field daily during operations. If a problem with the air stripper treatment system is noted, the Town of Collierville contacts Carrier. Carrier inspects the system, diagnoses the problem, and arranges for repairs to be implemented.

4.5 Groundwater Containment

The remedy for the Site uses the existing municipal wells at WP#2 to contain contaminated groundwater in the Memphis Sand beneath the plant. The daily production rate from these wells, during the remedial design, averaged approximately 750 gpm (combined flow), for a total daily flow rate of approximately 1.1 MGD. The interim action described in the *Schedule for Interim Actions at Water Plant #2* requires that the West Well be operated at 500 gpm to maintain containment.

4.5.1 Containment Objectives

Modeling performed in 1994 indicated that by maintaining groundwater extraction at WP#2, groundwater in impacted areas would be contained. This assessment also evaluated whether groundwater monitoring wells MW-60 and MW-62 (installed downgradient of WP#2) would detect any contamination if containment to the west of the Site was not adequate.

MW-60 was completed to a depth of 385 feet, with a 20-foot screened interval which was completed between 70 and 86 feet below the Town wells' screens. MW-62 was completed to a depth of 200 feet, with a 20-foot screened interval, between 39 and 75 feet above the top of the Town wells' screens. The Town wells are approximately 1,500 feet upgradient of MW-60 and MW-62.

Results of hydraulic modeling presented in 1994 were that MW-60 and MW-62 are adequate for monitoring containment because they are located properly downgradient of WP#2 to detect any bypass contaminants, and because any bypass contaminants should have had adequate time to travel from the source area to the monitoring wells.[4] Moreover, the modeling indicated that no additional groundwater extraction was required at WP#2 to effect containment of the plume.

This modeling was repeated during 1996 and 1997, using data obtained during a maintenance shutdown period at WP#2. Groundwater conditions were evaluated under static and pumping

[4] Both modeling efforts were performed to assess containment, particularly along the western edge of the site. Both the 1994 and 1996/1997 efforts demonstrated that adequate containment is provided by the West Well, ensuring that no TCE-contaminated groundwater bypasses the WP#2 containment system.

conditions. The 1997 verification modeling confirmed the placement of MW-60 and MW-62 as sufficient to detect loss of containment, and also confirmed the adequacy of the WP#2 pumping in containing contaminated groundwater. The conclusions included the following:

The static potentiometric surface between the facility and WP#2 indicated a uniform hydraulic gradient between the area where the Jackson/Upper Claiborne unit is absent and MW-60/MW-62.

- The composite capture zone from the East and West Wells includes the area of known contamination beneath the Carrier facility.

- With increased water demands from the Town of Collierville, pumping rates were expected to increase, thus causing the composite capture zone to increase in breadth.

- MW-60 and MW-62 are downgradient of the Town of Collierville wells to intercept any contamination flowing along the western edge of the capture zone or moving under the production wells.

As discussed above, the only prolonged interruption in containment which occurred since the remedy was formalized in the ROD has been the December 2003 shutdown due to the Smalley-Piper chromium problem. At this time, operations at WP#2 have been restored on an interim basis. However, to effect long-term containment, a long-term discharge option will need to be identified and implemented. Carrier is currently working with both TDEC-WPC to assess the potential for NPDES discharge of treated groundwater to Nonconnah Creek and the Town of Collierville to assess potential potable reuse.

4.5.2 Water Plant #2 Production Rates

The Town of Collierville wells have maintained production at approximately 1 MGD, with little downtime. Table 4-13 presents monthly flow rate data for WP#2. These data indicate that the average daily flow rate at WP#2 since January 2001 has been 1.03 MGD (718 gpm).

Table 4-13
Monthly Flow Rates at WP#2 2000 through 2004

Month	Gallons (gal)	Average Daily Flows (gal)
January-00	32,410,000	1,045,484
February-00	30,379,000	1,047,552
March-00	29,794,000	961,097
April-00	31,543,000	1,051,433
May-00	32,606,000	1,051,806
June-00	25,395,000	846,500
July-00	31,642,000	1,020,710
August-00	36,849,000	1,188,677
September-00	35,692,000	1,189,733
October-00	36,324,000	1,171,742
November-00	32,142,000	1,071,400
December-00	33,415,000	1,077,903
January-01	33,116,000	1,068,258
February-01	27,408,000	978,857
March-01	31,280,000	1,009,032
April-01	31,426,000	1,047,533
May-01	37,575,000	1,212,097
June-01	36,498,000	1,216,600
July-01	37,193,000	1,199,774
August-01	36,541,000	1,178,742
September-01	33,584,000	1,119,467
October-01	34,732,000	1,120,387
November-01	33,838,000	1,127,933
December-01	30,460,000	982,581
January-02	34,034,000	1,097,871
February-02	19,702,000	703,643
March-02	34,264,000	1,105,290
April-02	32,861,000	1,095,367
May-02	33,693,000	1,086,871
June-02	30,406,000	1,013,533
July-02	33,333,000	1,075,258
August-02	37,934,000	1,223,677
September-02	35,040,000	1,168,000
October-02	33,169,000	1,069,968
November-02	30,979,000	1,032,633
December-02	33,067,000	1,066,677
January-03	32,461,000	1,047,129
February-03	29,592,000	1,056,857
March-03	18,162,000	585,871
April-03	20,922,000	697,400
May-03	29,431,000	949,387
June-03	33,627,000	1,120,900

Table 4-13
Monthly Flow Rates at WP#2 2000 through 2004

Month	Gallons (gal)	Average Daily Flows (gal)
July-03	35,690,000	1,151,290
August-03	35,117,000	1,132,806
September-03	32,892,000	1,096,400
October-03	29,364,000	947,226
November-03	30,705,000	1,023,500
December-03	3,208,000	103,484

Note:
gal = gallons

4.5.3 Groundwater Monitoring Program/Effectiveness Monitoring

Groundwater samples have been collected from MW-60 and MW-62 every quarter since their completion. Results of sampling indicate no traces of TCE in either well. The absence of contamination at MW-60 and MW-62 indicate that capture was maintained at the approximately 1 MGD pumping rate, shared by the two production wells.

The WP#2 treatment system continues to effectively treat groundwater from the production wells. TCE concentrations in both municipal wells have increased since quarterly monitoring began in 1995, an indication that the containment system is actively drawing the contaminant plume. Peak concentrations were quantified onsite during the pre-RI and RI actions (1988 through 1992). Travel times for TCE in groundwater are expected to be variable given aquifer heterogeneities, but are estimated to be in the range of 10 to 15 years.[5] Therefore, current concentration increases at WP#2 are consistent with shallow groundwater (peak) concentrations below the MPA in the late 1980s and early 1990s.

Source area actions were begun at the MPA in 1995. Groundwater monitoring, reinitiated at MW-31 at the same time, indicated significant decreases in groundwater concentrations since

[5] Travel times to WP#2 modeled using advective groundwater transport were in the 15-year range; however, contaminants were first detected at WP#2 6 to 7 years after the first spill. Changes in grain size within the Memphis Sand aquifer are expected to contribute to this variability. It is expected, therefore, that actual transport times are variable, in the 10- to 15-year range.

the RI (completed in 1992). Therefore, it is reasonable to expect that concentrations will rise and peak at WP#2 sometime during the next 5 to 10 years, and then start to decline as cleaner groundwater (resulting from source control actions at the MPA) reaches the municipal well field. Mass removal rates at WP#2, therefore, are expected to increase as the main body of the plume beneath the Carrier plant is pulled toward WP#2 over the next several years.

It is important to note, however, that heterogeneities in the Memphis Sand aquifer may draw out the peak, and concentrations may not approach MCLs for a long period of time. TCE is expected to remain as residual contamination in the shallower, finer grained portions of the aquifer. These finer grained sediments are likely to be less transmissive than the main Memphis Sand aquifer, and therefore will likely yield less water to the groundwater extraction system than the main producing zone. Once peak concentrations diminish, therefore, it is likely that contamination will diffuse at low levels into the higher transmissivity sands for a long period of time.

4.6 Site Costs

Annual operating costs for the Site during the 2000 through 2004 period are shown in Table 4-14 below. Costs reflect annual operations and maintenance, sampling, reporting, and communications with federal and state agencies. Additional expenses beyond routine expenditures are noted.

Table 4-14
Annual O&M Costs 2000 through 2004

Year	Cost	Notes
2000	$45,000	
2001	$45,000	
2002	$115,000	Includes maintenance at WP#2, sampling at MPA, NRS, data validation and analysis.
2003	$200,000 *	Includes analysis/redesign of MPA, NRS, and response to Smalley-Piper chromium issues.
2004	$400,000 **	Includes installation/startup of MPA, NRS, response to Smalley-Piper chromium issues, and soil sampling, MPA system abandonment, and site management associated with the Project Everest expansion.

Notes:
MPA = Main Plant Area
NRS = North Remediation System
O&M = Operations and maintenance
WP#2 = Water Plant #2
* = Includes $100,000 for addressing Smalley-Piper chromium issues in 2003.
** = Includes $270,000 for addressing Smalley-Piper chromium issues through October 31, 2004.

5.0 PROGRESS SINCE LAST REVIEW

Significant progress at the Site has been effected since the *2000 Five-Year Review*, as presented in the following sections.

5.1 Protectiveness Statements from Last Review

As stated in the *2000 Five-Year Review*, the remedies implemented at the MPA, NRS, and WP#2 at the Carrier facility were protective of human health and the environment. Results of the previous 5-year review indicated the following:

- Mass removal at the two SVE treatment areas was ongoing, and significant mass reduction has occurred since the systems were installed. Approximately 14,100 lbs of TCE had been removed (as of the first quarter of 2000) from soils and shallow groundwater since the startup of the two SVE treatment systems.

- Concentrations in MW-31 (monitoring well used as an indicator to measure the effectiveness of the MPA SVE system) had decreased, indicating the MPA system was effective at mass removal and that mass contributions to the Memphis Sand Aquifer had decreased accordingly.

- TCE concentrations at WP#2 were increasing, indicating that the wells were drawing in contaminants formerly beneath the MPA.

- Groundwater extraction rates at the two Town of Collierville extraction wells (East Well and West Well) were being maintained at levels sufficient to contain the TCE plume. The Collierville wells had maintained production at 1 MGD with little downtime. Approximately 3,719 lbs of TCE have been removed (as of the first quarter of 2000) from the Memphis Sands since the system was installed (June, 1990). Moreover, at the time of the *2000 Five-Year Review*, the Town had indicated that increased demand requires additional pumping from WP#2, as evidenced by higher peak flows (5% of all daily flows are greater than 1.2 MGD).

The *2000 Five-Year Review* also indicated that the conditions at the Site were not expected to change in the near future, given the area's land use (industrial/commercial) and zoning controls currently in place. Access controls and surface conditions (e.g., pavement in the MPA) were adequate to prevent exposure.

The issues identified during the previous 5-year review, status of the recommendations, the follow-up actions, and the results of those actions at the NRS, MPA, and WP#2 are discussed in the following sections of this report and presented in Table 2-1 (Chronology of Site Events).

5.2 North Remediation System

The NRS was operational at the time of completion of the *2004 Five-Year Review.*

5.2.1 Status of Recommendations and Results of Follow-Up Actions from Last Review

As stated in the *2000 Five-Year Review,* mass removal rates at the NRS area had decreased significantly since system start-up. The confirmation sampling event of 1996 indicated that the majority of soil samples from the NRS area met the ROD cleanup goal of 533 µg/kg TCE. In 2001, Carrier submitted a work plan to USEPA for soil sampling at the NRS to determine if operational enhancements made since 1996 had achieved the ROD goal.

2002 Soil Sampling

As discussed previously (Section 4.2.3), soil sampling was conducted in 2002 at the NRS to gauge the effects of the remediation system. Sampling protocols and results are presented in detail in the *2002-2003 Annual Progress Report.* Data were compared to the ROD-prescribed remediation goal for TCE of 533 µg/kg; data exceeded the target goal at all depth intervals sampled (to approximately 20 feet bgs). The highest detections of TCE were typically encountered at depths between 10 and 20 feet bgs. At the NRS, high concentration residuals remain in moist, low permeability silts and clays that extend to a depth of 15 to 18 feet bgs; however, in sand below this depth interval TCE concentrations appeared to attenuate.

NRS Improvements and Mass Removal

The NRS and the MPA systems were shut down in 2002 pending repairs and system operation/equipment optimization. In concurrence with USEPA, repairs to both systems were deferred pending results of planned 2002 soil sampling activities. The NRS improvements implemented (November 2003 through March 2004) included blower replacement, and a larger moisture separator installation. As discussed in Section 4.2.4, the NRS system was restarted in November 2003 and optimized during the first quarter of 2004 to focus the SVE operation on additional mass removal from shallow soils.

Operation of the NRS following completion of optimization activities has resulted in enhanced removal of TCE mass. Based on system discharge data, as presented in Tables 4-1 and 4-2 of this report, the system has removed approximately 530 lbs of TCE since system re-start (November 2003), and approximately 800 lbs of TCE since 2000. As noted in the *2000 Five-Year* Review, mass removal rates were observed to decrease significantly after system start-up; however, recent system improvements (November 2003 through March 2004) were observed to enhance mass removal rates significantly.

Maintenance

The maintenance items (fence repairs, etc.), noted during the *2000 Five-Year Review* were addressed during the review period as part of normal O&M.

During the review period, the groundwater portion of the NRS system was decommissioned, as discussed in Section 4.2.2. Debris and packing media from the air stripper was shipped offsite as nonhazardous waste and stainless steel components were salvaged for recycling.

5.2.2 Implemented Actions Since Last Review

Carrier initiated the Project Everest facility expansion in August 2004. Soil excavation work associated with Carrier facility expansion at the Site entailed excavation of TCE impacted soils in the vicinity of the MPA as well as adjacent to the NRS. Soil sampling and analysis was performed from April 5 through 15, 2004, to assess the extent of TCE-impacted soil, and to

assess measures required for protecting plant expansion workers from any exposure during excavation activities. A total of 151 borings were completed in the MPA and 9 borings in the NRS area. The sampling procedures and the results of 2004 soil survey are discussed in detail in the 2004 Soil Survey Report, provided as Appendix L. Sampling procedures are summarized in Section 5.3.2 of this report.

TCE was detected at concentrations greater than the cleanup criterion (533 µg/kg) in 5 samples collected from discrete vertical intervals at one boring location (SA-206) in the NRS area. The NRS boring locations and the locations where TCE was detected greater than the cleanup criterion of 533 µg/kg are presented in Figure 5-1. The detected concentrations of TCE were observed to increase with depth at boring SA-206 with the highest concentration of 7,900,000 µg/kg encountered at depths between 18 and 20 feet bgs. Overall the results of the 2004 soil sampling and analysis indicate that vadose soil in the NRS between 0 and 20 feet bgs still contains TCE concentrations higher than the ROD cleanup criterion of 533 µg/kg. The analytical results of the borings performed at the boundary of the NRS (SA-200 through SA-205, SA-207, and SA-208) also indicate that the NRS source area does not extend beyond the boundary of the existing NRS.

5.3 Main Plant Area

The MPA had been temporarily decommissioned at the time of completion of the *2004 Five-Year Review,* as described in Section 5.3.2.

5.3.1 Status of Recommendations and Results of Follow-Up Actions from Last Review

The *2000 Five-Year Review* indicated that mass removal rates at the MPA system decreased significantly since system start-up, and had begun to approach asymptotic levels several times. System enhancements and intermittent operations (off during wet and rainy periods and on during dry conditions) were observed to enhance the mass removal under diffusion-limited conditions. In 2001, Carrier submitted a work plan for soil sampling at the MPA to determine if the ROD goal of 533 µg/kg of TCE had been achieved.

Soil Sampling

Soil sampling was conducted in 2002 at the MPA to gauge the effects of the remediation system. Sampling protocols and results are presented in detail in *2002-2003 Annual Progress Report*. Data were compared to the ROD-prescribed remediation goal for TCE of 533 µg/kg; data exceeded the target goal at several locations, from ground surface to an average depth of 15 to 20 feet bgs. Data showed significant residual mass present in the finer grained, low permeability materials (i.e., high clay-content), high moisture zones within the top 15 feet of the MPA. TCE concentrations in deeper, more permeable and lower moisture media were significantly lower, starting approximately 20 feet bgs.

MPA Improvements and Mass Removal

As discussed previously, the NRS and the MPA systems were shut down in 2002 pending repairs. The MPA was re-started in April 2004 following equipment replacement and upgrade. The goal of the system upgrade was to retrofit the existing system with a larger capacity moisture separator and an automated system for draining, treating, and pumping the water to a sanitary sewer line. This upgrade is discussed in Section 4.2.3. Since the system was re-started, operations have focused on additional mass removal from shallow soils. However, the MPA system was only operational through August 19, 2004, and was temporarily decommissioned due to Carrier's Project Everest facility expansion.

Based on system discharge data, as presented in Table 4-4, the system has removed approximately 30 lbs of TCE from April 2004 (re-startup) through August 19, 2004, (abandonment). The MPA system has removed approximately 1,368 lbs of TCE since 2000 and approximately 3,916 lbs of TCE since installation (1995).

Elevated Lead and Zinc Concentrations in MW-31

The *2000 Five-Year Review* indicated that USEPA and TDEC identified concerns regarding elevated lead and zinc concentrations in MW-31. Both agencies, however, were amenable to a data review process before determining additional actions. MW-31 was destroyed during TDOT road construction activities in 2000.

As discussed in Section 4.3.4, MW-31 was installed to monitor TCE concentrations migrating from the MPA and entering the Memphis Sand. Lead and zinc were noted in the RI to be potentially attributable to well construction materials (stainless steel screens with galvanized risers). In the near future, Carrier will review available data and evaluate the necessity of replacing MW-31 for further monitoring needs in this portion of the site.

Maintenance

The maintenance items (e.g., soil sampling, moisture separator maintenance) noted in the *2000 Five-Year Review* were addressed during the review period as part of normal O&M procedures.

In April 2004, the 40-gallon moisture separator was replaced with a large moisture separator with a capacity of 100 gallons and piped directly to Town of Collierville's sanitary sewer. As noted in Section 4.2.3, this alleviated multiple problems with the old demister tank.

The need for continued off-gas treatment was reviewed as part of the facility's Title V permit renewal in 2004. Review of MPA upgrades completed in April 2004, as well as planned modifications associated with the Project Everest expansion suggested that mass removal rates in excess of the currently permitted 0.5 tons per year for TCE may be possible. Therefore, carbon adsorption was retained for off-gas treatment.

5.3.2 Implemented Actions Since Last Review

Carrier initiated the Project Everest facility expansion in August 2004. The planned work involved a 300,000 square-foot expansion to the current Carrier facility, overlying the existing MPA SVE system and the former TCE spill area. As a result, the expansion activities have required excavation and demolition of existing below-ground and above-ground structures, including the MPA SVE system. The planned expansion work also entails excavation of potential TCE impacted soils.

Several activities were performed in 2004 to address the ramifications of facility expansion to the implemented remedies onsite including the following:

- 2004 Soil Survey — April 2004
- USEPA-Carrier Meeting to Discuss Project Everest — July 22, 2004
- Soil Excavation and Management Planning — August 2004
- Reconstructed MPA SVE System Scope of Work (SOW) — August 2004
- Abandonment of MPA SVE System, SVE wells, MW-6, and MW-1B — August 2004

These activities are discussed in detail in the following sections.

2004 Soil Survey — April 2004

Soil sampling and analysis were performed mainly to identify, delineate, and quantify the potentially TCE-impacted soil in the MPA in order to protect the facility expansion workers from any exposure to these soils during their excavation. Soil sampling accomplished two tasks:

- It identified the aerial and vertical extent of soil exceeding the 533 µg/kg criterion in the vicinity of the MPA.

- It delineated the extent of MPA and spill area soil requiring continued remediation via the reconstructed MPA SVE system.

The sampling procedures and the results of 2004 soil survey are discussed in detail in the *2004 Soil Survey Report*, provided as Appendix L.

Subsurface soil sampling and analysis were performed within the planned expansion area at the Site from April 5 through 15, 2004. A total of 151 borings (Geoprobe borings) were completed using direct push technology (DPT). DPT locations were concentrated in the facility expansion area suspected to contain TCE-impacted soils. The locations of these borings are presented in

Figure 5-2. Soil samples were collected for analysis using the EnCore® sampling technique (SW-846 Method 5035A) and were analyzed onsite using SW-846 Method 8260.

Approximately 146 of the 332 soil samples analyzed during the 2004 event exhibited detectable concentrations of TCE, cis-1,2-DCE, and/or vinyl chloride. TCE was detected at concentrations greater than the cleanup criterion of 533 µg/kg in a total of 50 samples (22 boring locations). TCE concentration contours (consisting of 533 µg/kg, 1,000 µg/kg, 10,000 µg/kg, and 100,000 µg/kg contour lines) for the two vertical intervals of 0 to 6 feet bgs, and 6 to 20 feet bgs are presented in Figures 5-3 and 5-4, respectively. A cross-section of the Site showing the MPA geologic information and the contaminant distribution information obtained during 2002 and 2004 soil sampling events is presented in Figure 5-5. Additional COCs detected in the MPA during 2004 sampling included cis-1,2-DCE and vinyl chloride. Overall, the results of the 2004 soil sampling and analysis indicate that the unsaturated soils in the MPA still contain concentration levels higher than the ROD cleanup criteria of 533 µg/kg. The areas exceeding the TCE cleanup criterion identified in Figures 5-3 and 5-4 were used to design the reconstructed MPA remedial system.

USEPA-Carrier Meeting to Discuss Project Everest — July 22, 2004

On July 22, 2004, Carrier representatives met with USEPA and TDEC-DSF in Atlanta to discuss the Project Everest expansion project. Carrier described the regulatory and economic pressures driving the expansion project, as well as the economic benefits to the community. The extent of the expansion, the need to manage TCE-impacted soil generated during construction activities in the MPA, and the need to abandon the MPA SVE system were discussed. Carrier also presented the conceptual design for the reconstructed MPA SVE system.

At this meeting, USEPA requested that Carrier prepare and submit the following documentation:

- A Scope of Work (SOW) describing proposed remediation-related activities required by Project Everest. This document addressed the following tasks:

- Abandonment of the MPA system.
- Soil management activities within TCE-impacted zones.
- Replacement of the MPA source-area system.
- Installation of a sub-slab ventilation (SSV) system to address any potential or future vapor migration concerns.

- Completion of this 5-year review to evaluate the protectiveness of the existing remedies.

Soil Excavation and Management Planning — August 2004

A *Soil Management Plan* (SMP) (XDD, August 12, 2004), (included as Appendix M) was developed to identify any TCE-impacted soil excavated during the expansion work and provide procedures for onsite management, including characterization, separation, and containment of potentially hazardous soils generated during Site construction activities. The primary goal of the SMP was to identify soils acceptable for reuse onsite; soil which did not qualify for onsite reuse was to be managed according to the protocols set forth in the SMP. Protocols dictating transportation of soils to offsite treatment and/or disposal facilities were also included in the SMP. The following is an overview of the onsite soil management protocols and procedures dictating transportation of soils to offsite treatment and/or disposal facilities.

TCE-impacted areas were delineated using the extensive soil sampling and analysis during the 2002 and 2004 soil surveys. The expansion area that required compliance with all SMP protocols, described as the "Hot Zone," is presented in Figure 5-6. All soil outside of the Hot Zone has been designated to be handled as nonhazardous. However, any soil identified as being potentially VOC-impacted and/or hazardous is required to be managed under the protocols set forth in the SMP.

Soil inside the Hot Zone is required to be screened and managed in accordance with the protocols as described in the SMP and summarized below.

- Soil excavation occurring within the Hot Zone is required to be performed by Occupational Safety and Health Act (OSHA) 40-hour trained contractors.

- Excavated soils from Hot Zone must be screened using a PID fitted with a 10.6eV lamp to segregate impacted and non-impacted soil.

- Soil generated in the Hot Zone is required to be delivered to the containment area as screening results dictate.

Once the soil is delivered to the containment area, soil characterization (sampling and analysis) has to be performed to determine the ultimate reuse or disposal options per the SMP. Soil exhibiting TCE concentrations below the 533 µg/kg criterion are to be left onsite. Offsite transportation, treatment (if required), and disposal is to be managed on an as-needed basis based on soil characterization results.

In accordance with USEPA's Offsite Policy, Carrier notified USEPA of its preferred disposal options in a letter dated July 30, 2004, and included as Appendix N. If required, offsite treatment and disposal will be performed at one or more of the following facilities:

VonRoll WTI Incineration Facility
(Heritage)
USEPA ID#OHD980613541
East Liverpool, Ohio 43920
330/385-7337

Deer Park Facility (Clean Harbors — incineration and landfill facility)
USEPA ID#TXD055141378
2027 Battleground Road
LaPorte, Texas 7571
281/930-2300

Heritage RCRA Subtitle C Landfill
USEPA ID#IND980503890
4370 West County Road 1275 North
Roachdale, Indiana 46172
765/435-2704

Lone Mountain Landfill (Clean Harbors)
USEPA ID#OKD065438376
Route 2 Box 170
Waynoka, Oklahoma
580/697-3500

Reconstructed MPA SVE System SOW — August 2004

As discussed previously, the planned expansion of the Carrier facility required demolition of the MPA SVE system. To remain in compliance with the ROD for the Site, reconstruction and continued operation of the MPA remediation system was necessary, and USEPA requested submittal of a SOW describing remediation activities required due to the Project Everest expansion. The SOW submitted to USEPA August 18, 2004, (Appendix B) presents the system design for the reconstructed MPA SVE. A SSV system will also be integrated into the expansion as a protective measure, in the event that vapor migration to the facility expansion building becomes an issue in the future. The design of the SSV system was also presented in the SOW. The SOW is described in more detail below.

Reconstructed MPA SVE

Reconstruction and continued operation of the MPA SVE system will provide continued treatment of the MPA source soils, to ensure ongoing compliance with ROD. The reconstructed MPA SVE system will focus on remediating the areas that were targeted by the original MPA SVE system and will expand remediation into areas exceeding the TCE cleanup criterion identified by the most recent investigations (2002 and 2004). The reconstructed MPA system will have the capacity to address a greater area and will have a greater total flow rate than the existing MPA system. The proposed SVE system emulates the existing MPA SVE design and the site-specific design criteria of the existing MPA SVE system, as presented in the *Final MPA SVE Design Report* (EnSafe, 1994).

The proposed SVE well layout consists of 49 multilevel well locations inside the Project Everest expansion footprint, approximately 40 feet on-center (20-feet radius of influence [ROI], in accordance with the *Final MPA SVE Design Report* and the ROD). The proposed SVE well layout is presented in Figure 5-7. Wells will be installed into three discrete intervals for more versatile operation and to maximize the system performance:

- 44 shallow wells (screened at an interval of 3.5 to 8.5 feet bgs target the shallow zone (clayey silts).

- 49 deep wells (screened at an interval of 13.5 to 23.5 feet bgs) target the deep zone (clayey silts).

- 3 deep sand wells (screened at an interval of 30 to 40 feet bgs) target the deep sand zone (fine to medium sands).

The construction details of the vapor extraction wells are presented in Figure 5-8a (Shallow and Deep Nested SVE wells) and Figure 5-8b (Deep Sand SVE wells).

All wells were designed to be finished below grade. In general, the SVE manifold will include two overhead main manifold lines (i.e., located in the ceiling trusses), and individual lateral lines (subsurface) from each SVE well head to the main lines. The two overhead main extraction lines will be routed to the new equipment building where all the treatment equipment and process instrumentation will be housed.

Design flows and vacuums at individual wellheads are based on the *Final MPA Design Report* (EnSafe, September 1994) and the performance data of the existing MPA SVE system (see Table 1 in Appendix B of this document). The SVE system is designed to extract vapors as outlined below:

- From the shallow wells (screened 3.5 to 8.5 bgs) at flow rates between 8 and 10 cfm under an approximate vacuum of 50 to 80 inches of water;

- From the deep wells (screened 13.5 to 23.5 bgs) at flow rates between 10 and 12 cfm under an approximate vacuum of 50 to 80 inches of water; and

- From the deep sand wells (screened 30 to 40 bgs) at flow rates above 15 cfm under an approximate vacuum of 40 to 60 inches of water.

Subslab Ventilation System

The design basis for the proposed SSV system is to prevent potential vapor intrusion into the proposed expansion building. The SSV system design incorporates the use of a negative vacuum (vacuum greater than the design ventilation vacuum in the expansion building, 0.10 inches of water) beneath the expansion building via a network of horizontal well screens. The applied negative vacuum beneath the expansion building floor slab will prevent the accumulation of the COC vapors beneath the slab or in the pore space of the backfill material (i.e., crushed limestone), thereby preventing the migration of the COC vapors into the expansion building.

The proposed SSV system layout is presented in Figure 5-9. The SSV system layout consists of main line(s), branch lines (legs), horizontal screens at 100-foot on-center spacing, and process equipment housed in the SVE Equipment Building. Horizontal well screens will be installed in the fill material at an approximate depth of 2 feet below the bottom of the proposed floor slab. The designed system total flow rate is approximately 100 to 150 cfm.

Schedule

At this time, Project Everest construction activities are expected to continue through winter and spring 2004/2005. MPA reconstruction activities and SSV construction will be implemented during spring/summer 2005.

Abandonment Of MPA SVE System, MW-6, And MW-1B — August 2004

The MPA SVE system was abandoned in August 2004 due to the Carrier facility expansion, as discussed in the SOW. MPA SVE system abandonment included the following:

- Vertical SVE Well and Monitoring Well Abandonment
- Horizontal SVE Well and Subsurface Manifold Removal
- SVE Equipment Building and Equipment Removal

All existing MPA SVE wells and piezometers and two groundwater monitoring wells (MW-6 and MW-1B) were abandoned. Prior to abandonment, the two monitoring wells (MW-6 and MW-1B were sampled for VOCs, lead, and zinc. Groundwater was also analyzed for chromium. Analytical data from the April 21, 2004 event and the June 30, 2004 event are shown in Table 5-1 and included in Appendix O.

Table 5-1
Analytical Results from MW-6 and MW-1B (µg/L)

Compound	MW-6		MW-1B	
	4/21/04	6/30/04	4/21/04	6/30/04
TCE	260	290	760	1,300
Total 1,2-DCE	33	36	930	660
Vinyl Chloride	<2	<2	<5	<20
Lead	7	<5	<1.9	<5
Zinc	7,200	4,400	8,500	7,100
Total Chromium	<1.4	<10	<1.4	8.8
Hexavalent Chromium	<10	<10	<10	<10

Notes:
µg/L = micrograms per liter
TCE = trichloroethylene
DCE = dichloroethylene
<2 = not detected at a method detection limit of 2 µg/L

It should be noted that prior to development of final construction plans, MW-10 was also sampled, in case this well also required abandonment. However, the final construction plans did not affect this location and MW-10 was left in place. Analytical data from this well exhibited TCE concentrations significantly higher than RI data, exceeding 10,000 µg/L in both the April and June sampling events. Carrier will evaluate this well to determine whether these TCE concentrations are representative of the Memphis Sand aquifer, or if the well's integrity has been compromised (see Section 9.0). Data from MW-10 are also included in Appendix O.

Well abandonment was performed in accordance with the standard procedures and guidelines set by the Memphis and Shelby County Health Department (MSCHD). Subsurface manifold piping from the vertical SVE wellhead to the equipment building and the two horizontal SVE wells were also completely removed by excavation. Pipe trenches were backfilled with native materials. Existing MPA SVE system equipment and process instrumentation was

disconnected and removed from the existing Equipment Building. The existing equipment building was demolished in accordance with all local requirements. These activities will be discussed in documents regarding the MPA replacement system.

5.4 Water Plant #2

WP#2 was operational at the time of completion of the *2004 Five-Year Review.*

5.4.1 Status of Recommendations and Results of Follow-Up Actions from Last Review

During the previous 5-year review process, interviews with the Town of Collierville's Director of Public Utilities indicated a breakdown in communication between Carrier and the Town of Collierville. As stated in the *2000 Five-Year Review*, further coordination was required between Carrier and the Town of Collierville with respect to each party's responsibilities regarding maintenance of WP#2 to ensure continued operation in an efficient manner.

Under the 1996 agreement between Carrier and the Town of Collierville (included as Attachment C), maintenance of the wells, pumps, and distribution system is the responsibility of the Town of Collierville Public Works Department. The pressure drop across the air stripper columns and other performance indicators are being monitored on a regular basis by the Town of Collierville for gradual changes in performance.

Since the *2000 Five-Year Review*, coordination between Carrier and the Town of Collierville regarding the maintenance of WP#2 has improved. If a problem with the air stripper treatment is noted, the Town of Collierville contacts Carrier. Carrier inspects the system, diagnoses the problem, and arranges for repairs to be implemented. However, communications with the Town of Collierville proved to be inadequate when WP#2 was shut down in March/April 2003 due to increasing chromium concentrations from the Smalley-Piper Site. This breach in communications was documented to USEPA in the notice sent on May 8, 2003, (see Appendix E). However, following this shutdown, Carrier and the Town of Collierville

worked closely to ensure continued operation of WP#2 despite the presence of chromium in the well field. Operations were sustained until December 2003, as discussed in Section 4.4.3.

Currently, Carrier and the Town are operating WP#2 on an interim basis, discharging treated groundwater to the Town's POTW until further data on the chromium plume is acquired.

Air Stripper Repair and Maintenance

Slight increases in TCE concentrations were quantified in air stripper effluent in 2001. Additional system inspections were performed in December 2001 to determine the cause of reduced treatment efficiencies. Investigations revealed that well maintenance activities by the Town had caused fouling/plugging in the air stripper distribution laterals; pump maintenance had also increased overall well yields. As discussed in detail in Section 4.4.3 of this report, maintenance activities in early 2002 improved treatment efficiencies such that TCE in air stripper effluent was below detectable limits.

5.4.2 Implemented Actions Since Last Review

As discussed in Section 4.4.3, the WP#2 was shut down on December 3, 2003, due to increasing chromium concentrations. Carrier submitted the *Schedule for Interim Actions at Water Plant #2* in June 2004, including evaluation of both short- and long-term operation options. WP#2 was re-started in November 2004, following completion of the tie-in connection to the sanitary sewer. The startup procedures followed for WP#2's restart and the analytical data from startup are presented in Section 4.4.3 of this report.

As discussed in the *Schedule for Interim Actions at Water Plant #2*, WP#2 was re-started primarily to operate for 6 months at a flow rate of 500 gpm to gauge chromium concentration trends in West Well, discharging to the Collierville POTW. An evaluation of long-term discharge options will be conducted during the 6-month period and will include pilot testing of chromium treatment technologies. Carrier is currently implementing this plan.

6.0 FIVE-YEAR REVIEW PROCESS

The following elements of the 5-year review process were completed in 2004:

- Administrative components, including notification of potentially interested parties
- Community notification and involvement
- Document review
- Data review
- Site inspection
- Interviews

6.1 Administrative Components

USEPA notified Carrier and TDEC of the start of the 5-year review process at a meeting in Atlanta on July 22, 2004. Carrier was asked to prepare the *2004 Five-Year Review* for submittal to USEPA.

The review team is described in Table 6-1.

Table 6-1
Five-Year Review Project Team

Role	Team Member	Affiliation
Project Manager	Femi Akindele	USEPA
	Jordan English	TDEC
	Jamie Woods	TDEC
Primary Authors	Lori Anne Goetz	EnSafe Inc. (Carrier consultant)
	Bruce Cliff	Xpert Design and Diagnostics, Inc. (Carrier consultant)
Community Involvement Coordinator	Linda Starkes	USEPA
Technical Support	Bryan Kielbania	UTC (project manager for Carrier Corp.)
	Frank Sizemore	Carrier Corp.
	Lori Anne Goetz	EnSafe Inc. (Carrier consultant)
	Bruce Cliff	Xpert Design and Diagnostics, Inc. (Carrier consultant)
	Mark Allen	SAS Environmental Inc. (Carrier consultant)

Components of this five year review were outlined in Section 1.

6.2 Community Notification

At USEPA's direction, Carrier performed community notification that a 5-year review was being performed via a public notice in the *Collierville Herald* on September 2, 2004, and September 9, 2004. A copy of this public notice is provided in Appendix P.

Once the *2004 Five-Year Review* is finalized, a public notice indicating completion of the review, and its findings will be placed in the *Collierville Herald.* Copies of the *2004 Five-Year Review* will be placed in the two information repositories (shown below) and on the USEPA website (http://www.epa.gov/Region4/waste/npl/npltn/carairtn.htm):

EPA Record Center, 11th Floor
61 Forsyth Street, SW
Atlanta, Georgia 30303

Lucius E. & Elsie C. Burch, Jr., Library
501 Poplar View Pkwy
Collierville, Tennessee 38017

6.3 Document Review

The following documents generated since the *2000 Five-Year Review* was issued were reviewed for Site history and remediation data:

- *2001 Annual Progress Report, UTC-Carrier Air Conditioning, Collierville, Tennessee* (EnSafe, June 19, 2002)
- *2002/2003 Annual Progress Report, UTC-Carrier Air Conditioning, Collierville, Tennessee* (EnSafe, June 30, 2004)
- *Schedule for Interim Actions at Water Plant #2, UTC-Carrier Air Conditioning, Collierville, Tennessee* (EnSafe, June 30, 2004)

- *Soil Management Plan: Everest Expansion Project, Carrier Air Conditioning Site, Collierville, Tennessee* (Xpert Design and Diagnostics, LLC; August 12, 2004)

- *Scope of Work: Reconstruction of Main Plant Area Remedial System, Carrier Air Conditioning Superfund Site, Collierville Tennessee, EPA ID: TND04406222* (Xpert Design and Diagnostics, LLC; August 18, 2004)

- NPDES permit application addressed to Mr. Ed Polk, TDEC Division of Water Pollution Control, from Mrs. Lori Goetz, EnSafe Inc., dated September 13, 2004.

These documents, in addition to the final RI (EnSafe, March 27, 1992) and FS (EnSafe, March 31, 1992), were the primary sources for data evaluated in this report. A complete list of site-related documents generated from 1992 through 2004 is provided in Appendix Q.

Pertinent sections of these documents (including RAOs, cleanup standards, etc.), are summarized in Sections 4 and 5 of this 5-year review.

6.4 Data Review

Operations and monitoring data for the Site are summarized in Section 4 of the *2004 Five-Year Review,* for each component of the remedy.

Analytical data obtained during planning for the Everest expansion project are summarized in Section 5 of the *2004 Five-Year Review* and are presented in Appendix L.

6.5 Site Inspection

The Site inspection was performed on September 22, 2004. The following team members were present for the Site inspection:

- Femi Akindele, USEPA
- Lori Anne Goetz, EnSafe

- Tom Trenholm, XDD
- Frank O'Connell, SAS
- Frank Sizemore, UTC-Carrier
- Charlie Sepko, UTC-Carrier

The inspection team reviewed ongoing operations associated with Project Everest expansion activities near the MPA and the NRS. During the Site inspection, Mr. Akindele noted the following items/issues:

- An updated schedule for Project Everest and MPA replacement activities would be required with submittal of the Five-Year Review report.

- The 5-year review document would be required to evaluate protectiveness of the Site remedies, with respect to the shutdown of WP#2 caused by chromium contamination associated with the Smalley-Piper Site, as well as temporary shutdown of the MPA system.

- USEPA would like recommendations from UTC-Carrier on how state and federal regulators can begin facilitating discussions regarding the potential use of treated WP#2 effluent as potable drinking water.

6.6 Interviews

USEPA indicated that several public officials were interviewed to seek their opinions relative to the RA activities at the Site. In addition, USEPA was contacted by community members as a result of the public notices placed in the *Collierville Herald*.

In documentation transmitted to UTC-Carrier via electronic mail on October 13, 2004, and included as Appendix R, USEPA indicated that no comments were received from the community to indicate concerns about the remedy implemented at the Site meeting its objectives. However, USEPA stated that many of the comments received from the community indicated

concern about the potential adverse effect of the Smalley-Piper chromium plume on continued effectiveness of the Site remedy. USEPA's summaries of telephone interviews are also included as Appendix R.

7.0 TECHNICAL ASSESSMENT

This section presents the assessment of the protectiveness of the implemented remedies at the Site, particularly with respect to the following three questions, in accordance with the USEPA Comprehensive Five-Year Review Guidance (June 2001):

- Question A — Is the remedy functioning as intended by the decision documents?
- Question B — Are the exposure assumptions, toxicity data, cleanup levels, and RAOs used at the time of remedy selection still valid?
- Question C — Has any other information emerged that could call into question the protectiveness of the remedy?

7.1 Evaluation of Question A — Is The Remedy Functioning as Intended by the Decision Documents?

The ROD-stated objective for remedial actions at the Site is protection of the underlying Memphis Sand aquifer. Soil sampling events conducted in 2002 and 2004 indicate that residual mass is present in both the MPA and NRS source areas, associated with high moisture-content clayey soil. Carrier implemented improvements in the NRS to enhance mass removal from this zone in 2003/2004, and will be expanding the MPA system during 2004/2005. However, as noted in the ROD, remedial actions in these source areas will be implemented to achieve:

> A cleanup level for the TCE-contaminated soil...[of] approximately 533 µg/kg or until in EPA's determination, it is demonstrated that contaminant levels have ceased to decline over time, and are remaining constant at some statistically significant level above remediation levels" (ROD, p. 48).

Recent and planned modifications to the MPA and NRS will indicate whether the 533 µg/kg goal is achievable. However, maximizing mass removal in both systems provides long-term protection to the Memphis Sand and meets the intent of the decision document.

Operation of WP#2 both contains the TCE plume, which extends approximately 2,000 feet from the Carrier facility to the WP#2 well field, and removes mass from the Memphis Sand aquifer. While mass removal is valuable in achieving the long-term goal of restoration, the capture zone of WP#2 prevents TCE from migrating beyond the WP#2 well field and impacting potential downgradient users. The ROD contemplated operations at WP#2 would continue for 30 years, and this 5-year review shows that containment will be required for the foreseeable future. WP#2 continues to function as anticipated by the ROD, and will remain an integral part of Site management due to the size and magnitude of the TCE plume.

The functionality of each component of the Site remedy is discussed in detail below.

7.1.1 NRS Remedial Measure

Remedial Action Performance

As detailed in Sections 4 and 5, the NRS system continues to function as designed in the removal of TCE from soil identified during the RI. Approximately 12,460 lbs of TCE have been removed by vapor extraction since the start-up of the system (January 1992) based on system discharge data. The NRS system was reconfigured and optimized in November 2003; TCE mass removal rate since the November 2003 reconfiguration and optimization has been at its highest levels for this review period.

System Operations/O&M

Operating procedures have optimized the NRS system and provided increased performance at removing TCE from the soil. The O&M costs have stayed within the expected range for the NRS with no significant or unexpected variances to indicate problems with the remedy.

Opportunities for Optimization

There are no further expected opportunities for optimization of the NRS system performance or O&M costs at this time. Carrier just completed optimization of the NRS in 2003/2004 and any further optimization opportunities would be considered and implemented after operational improvements are assessed and data evaluated.

Early Indicators of Potential Issues

No early indicators of potential remedy failure (e.g., equipment breakdowns) or changes in the scope of operations were identified. Continued remediation of the TCE from the affected soils by the NRS system is maintaining the protectiveness objective.

Implementation of Institutional Controls and Other Measures

Site controls such as fencing and limited access to the NRS area prevent unauthorized contact with TCE affected soils. No activities were observed that would have violated the institutional controls.

7.1.2 MPA Remedial Measure

Remedial Action Performance

As detailed in Sections 4.2 and 5.3, the MPA system has functioned as designed in the removal of TCE from soil identified during the RI. Approximately 3,916 lbs of TCE have been removed by vapor extraction since the start-up of the system (1995) based on system discharge data.

Since the system was re-started in April 2004 and optimized during the second quarter of 2004, operations have focused on additional mass removal from shallow soils. However, the MPA system was only operational for a few months and was abandoned in August 2004 due to the Carrier facility expansion.

The MPA system is currently being reconstructed and is scheduled to be restarted in Summer 2005. The impacts of system reconstruction on overall remedy performance are discussed in the following sections.

System Operations/O&M

Operating procedures optimized the MPA system and provided increased performance at removing TCE from the soil up to the date of its abandonment/demolition in August 2004. The O&M costs have stayed within the expected range for the MPA with no significant or unexpected variances to indicate problems with the remedy.

Opportunities for Optimization

As presented in Section 5.3.2, the facility expansion over the MPA remediation area required the demolition of the SVE system. The 2002 and 2004 soil surveys identified a larger area of residual contamination in excess of the 533 µg/kg criterion than had been addressed during RD. The differences in results were attributed to soil heterogeneity and better recovery associated with the Encore® sampling technique. The demolition of the SVE system and the incorporation of new soil data provided an opportunity to compare alternative remedies with the SVE remedy selected by the ROD. A remedial option matrix table of approaches most certain to meet the ROD objectives is presented in Appendix S and the options are briefly discussed below:

Option 1 Reconstructed SVE

- Install new multilevel wells for improved targeting of affected soil strata.
- Install more SVE wells (49 versus 7) across a greater footprint as defined by the 2002 and 2004 soil sampling.
- Increase flow from 240 to 550 cfm.
- Compatible with facility expansion and construction schedule.
- Cost: $400,000 to $500,000 plus unquantified O&M costs

Option 2 Limited Soil Excavation and SVE

- Remove most impacted soils (top 10 to 15 feet) via excavation
- Install expanded SVE system.
- ROD modification is required.
- Disruptive to existing structures and will impact proposed construction.

- Not compatible with facility expansion and construction schedule.
- Excavation cost: $630,000
- SVE installed following excavation ($400,000 to $500,000 plus unquantified O&M costs)
- Total cost: approximately $1,130,000 plus unquantified O&M costs
- Structural and construction costs are unknown.

Option 3 Chemical Oxidation – Soil Mixing

- Overcomes permeability conditions and contact issue by soil mixing with large augers and injecting oxidant.
- ROD modification is required.
- Disruptive to existing structures and will impact proposed construction.
- Not compatible with facility expansion and construction schedule.
- Soil mixing/stabilization Cost: approximately $1,000,000
- Structural and construction costs are unknown.

The reconstructed SVE option was selected for two reasons:

1) The existing ROD remedy (Option 1 — Reconstructed MPA SVE), has demonstrated itself to be effective and once reconstructed, mass removal will continue at an improved rate, removing TCE from impacted soil. As stated previously, mass removal provides long-term protection of the underlying Memphis Sand Aquifer.

2) Options 2 and 3 more aggressively address the potential soil permeability limitations through excavation and soil mixing, respectively. Option 2 will still rely on SVE for remediation of soils below the point of excavation. Option 3 cannot provide completing mixing due to existing facility infrastructure and, to a lesser degree, soil permeability limitations in reaching the ROD objectives. Both options will have structural impacts to existing buildings and the expansion building, the cost for which is unknown.

Evaluation and comparison of the alternative technologies presented does not show that they are any more protective of the underlying Memphis Sand aquifer than the remedy originally selected. Also, the increased costs for the alternatives, the impacts to the present facility and its expansion, and the absence of a significant benefit from accelerated activities do not justify a change in the remedy.

As noted previously, use of data acquired in 2002 and 2004 in the redesign of the MPA has allowed Carrier to optimize construction. The reconstructed MPA system offers the maximum flexibility for operations and mass removal, including:

- Treating a larger area than the previous MPA system (94,200 square feet versus 31,400 square feet).

- Accommodating higher total flow rates than the previous MPA system (550 cfm versus 240 cfm).

- Treating three discrete depth intervals, allowing operations personnel to target recalcitrant zones.

- The reconstruction of the MPA will allow greater mass removal and thus will function in accordance with decision documents.

Early Indicators of Potential Issues

As discussed previously in this report, the MPA system is currently being reconstructed and is scheduled to be restarted in Summer 2005. Therefore, any early indicators of potential remedy failure (e.g., equipment breakdowns) or changes in the scope of operations cannot be identified at this time. The continued remediation of the TCE from the affected soils by the reconstructed MPA SVE system is expected to maintain the protectiveness objective.

Implementation of Institutional Controls and Other Measures

Site controls are adequate. Site controls such as fencing and limited access to the MPA area prevent unauthorized contact with TCE affected soils. No activities were observed that would have violated the institutional controls.

7.1.3 WP#2 Remedial Measure

Remedial Action Performance

As detailed in Sections 4 and 5, the WP#2 system is operating as designed for the containment and removal of TCE from groundwater as specified in the ROD. Groundwater samples have been collected from monitor wells MW-60 and MW-62, downgradient of WP#2, every quarter since their completion. Results of sampling indicate no traces of TCE in either well. As demonstrated by groundwater modeling performed in 1994 and 1997, the absence of TCE contamination at MW-60 and MW-62 indicates that effective capture has been maintained. Since installation, the WP#2 treatment system has removed 5,222 lbs of TCE from the groundwater.

During the 6-month interim operation period, the planned pumping rate for WP#2 is 500 gpm. Data from the interim operation period will be used to gauge chromium concentration trends in the West Well. Modeling described in the *Schedule for Interim Operations at Water Plant #2*

indicated that operating West Well at the 500 gpm flow rate will sufficiently contain the TCE plume and thus function in compliance with Site decision documents.

System Operations/O&M

As discussed in Section 4, the presence of chromium in the groundwater extracted by WP#2 resulted in the shutdown of WP#2 on December 3, 2003. The construction of the conveyance piping from WP#2 to the sanitary sewer on Byhalia Road has been completed and WP#2 has been operating since November 8, 2004. O&M procedures will maintain the effectiveness of the WP#2 system.

O&M costs have dramatically increased in 2003 and 2004 as a result of adapting WP#2 for discharge to the sanitary sewer due to the presence of chromium. While TCE treatment costs are expected to remain consistent with historical trends for the foreseeable future, incorporation of engineering controls for chromium removal is expected to incur significant cost above and beyond chlorinated VOC removal costs contemplated by the ROD.

Opportunities for Optimization

There are no further expected opportunities for optimization of the WP#2 system for TCE containment, remediation performance, or O&M costs. Following modifications to account for the chromium issue, any further optimization opportunities would be considered and implemented after operational improvements are assessed and data evaluated.

Early Indicators of Potential Issues

No early indicators of potential remedy failure (e.g., equipment breakdowns) were identified; however the presence of chromium has and may continue to impact the scope of operations. Provided the chromium issue is resolved, continued containment and remediation of the TCE from the groundwater by the WP#2 system will continue to meet the protectiveness objective.

Implementation of Institutional Controls and Other Measures

Site controls are adequate as stated in Section 4.1. The restriction of water wells within 0.5 miles of the Site provides an institutional control for the groundwater. Zoning restrictions in the Town of Collierville indicate that future land use will be consistent with ROD cleanup standards. No activities were observed that would have violated the institutional controls.

7.2 Evaluation of Question B — Are Exposure Assumptions Still Valid?

The *2000 Five-Year Review* reviewed risk-assessment assumptions behind the development of cleanup goals at the Site. The 2000 review concluded that soil cleanup goals protective of groundwater (i.e., based on the MCL) were still protective of site workers. MCLs for TCE and its degradation products had not changed since ROD issuance in 1992.

This section reevaluates the risk-based assumptions developed for the Site in accordance with the USEPA *Comprehensive Five-Year Review Guidance.*

7.2.1 Evaluation of Standards and TBCs

Soil cleanup criteria for the Carrier Air Conditioning Site and the basis for these criteria are shown in Table 7-1.

Table 7-1
Cleanup Levels — Carrier Air Conditioning Site

Matrix	Contaminant	Goal	Basis
Groundwater	TCE	5 µg/L	MCL
	Cis-1,2-DCE	70 µg/L	MCLG
	Trans-1,2-DCE	100 µg/L	MCLG
	PCE	5 µg/L	MCL
	Vinyl Chloride	2 µg/L	MCL
	Zinc	5,000 µg/L	SMCL
	Lead	15 µg/L	Treatment Technique Action Level
Soil	TCE	533 µg/kg	MULTIMED Leaching Model – based on Protection of groundwater (MCL)

Notes:
Taken from Carrier Air Conditioning Record of Decision, (USEPA, 1992)
MULTIMED assumptions can be found in the *Final Remedial Investigation Report, Collierville Site* (EnSafe, 1992).
MCL = Maximum contaminant level
MCLG = Maximum contaminant level goal
µg/L = micrograms per liter
PCE = tetrachloroethylene
TCE = trichloroethylene
DCE = dichloroethylene

The MCL is the endpoint for both groundwater and soil RAOs, and the TCE MCL has not been revised. The protectiveness of the remedy is not called into question based on the standards identified in the ROD. Similarly, neither newly promulgated standards nor to-be-considered criteria (TBCs) have changed that would affect the protectiveness of the remedy.

7.2.2 Progress toward Meeting RAOs

The following RAOs are inherent to the Carrier ROD:

- Contain TCE plume at the WP#2 well field.
- Treat WP#2 groundwater for continued use by the Town of Collierville.
- Treat soil at the MPA and NRS to remove mass and provide long-term protection of the underlying Memphis Sand aquifer.
- Treat Memphis Sand groundwater to meet beneficial reuse standards as a drinking water source.
- Prevent unauthorized water use within the TCE plume area.

Compliance with Groundwater Containment RAO

As discussed in both the *2000 Five Year Review* and the *2002/2003 Annual Progress Report*, the WP#2 well field functions as an effective groundwater containment system for the Carrier TCE plume. Downgradient monitoring wells do not exhibit chlorinated solvent contamination. Mass removal rates from WP#2 remain high, and concentration trends appear to be changing consistent with the Site conceptual model. Therefore, the groundwater containment RAO is met as long as WP#2 remains operational.

The temporary shutdown incurred at WP#2 due to chromium from the Smalley-Piper Site will not impact containment of the TCE plume over the short term. Groundwater velocities suggest

advective transport times of 100 to 270 feet per year. As discussed in the *Schedule for Interim Actions at Water Plant #2*, resumption of pumping at West Well within one year of shutdown would re-establish a capture zone that would contain TCE that has migrated during the intervening year. WP#2 operations were re-started in November 2004.

Given the mass of contaminants present in the plume between the Site and the WP#2 well field, continued long-term operations at WP#2 is critical to meeting this RAO.[6]

Compliance with Groundwater Treatment RAO

The two air strippers installed at WP#2 continue to treat TCE-contaminated groundwater to concentrations below MCLs. The remedy meets the groundwater treatment RAO.

Compliance with Soil Treatment RAO

As discussed in Section 4, both the NRS and MPA systems have achieved significant mass removal since operations began in 1989 and 1995, respectively. Continued mass removal will minimize long-term impacts to the underlying Memphis Sand aquifer. The ROD stated:

> The cleanup level for TCE-contaminated soil will be approximately 533 µg/kg, or until in EPA's determination it is demonstrated that contaminant levels have ceased to decline over time, and are remaining constant at some statistically significant level above remediation levels in the area of remediation. (ROD, p.48)

Sampling performed in 2002 and 2004 indicated several areas still exceeded the 533 µg/kg criterion, despite the documented mass removal. As discussed earlier, the number of exceedances was higher than the initial RI and RD sampling, potentially due to the use of

[6] Modeling discussed in the *Schedule for Interim Actions at Water Plant #2* indicated that short-term shutdowns at WP#2 less than 1 year in duration can be accommodated, given the significant back-capture provided by West Well operating at 500 gpm. If WP#2 startup were delayed beyond 1 year, some migration would occur, at an estimated rate of 100 to 200 feet per year, until the well field was restored to operation. WP#2 would recover any TCE up to its back-capture point (approximately 250 to 300 feet downgradient of West Well), but any TCE beyond this point would remain in the aquifer, and would attenuate through natural diffusion, dispersion, and adsorption processes. The progress of the plume would be assessed at downgradient compliance wells MW-60 and MW-62.

SW-846 Method 5035 sampling techniques.[7] It is unclear at this time whether the specific soil cleanup goal of 533 µg/kg is achievable in the silty clay matrix present at the NRS and MPA. However, regardless of compliance with a numeric cleanup goal, the RAO of long-term protection is met through ongoing mass removal at these two source areas.

Compliance with Groundwater Restoration RAO

Groundwater restoration at the Site is less a function of the groundwater remedy (containment using the WP#2 well field) than the source area remedies at MPA and NRS.

Empirical evidence suggests a 7-year travel time from the MPA source area to the Town of Collierville well field. Contaminant trend changes observed in recent monitoring data may indicate that operation of source area remediation systems has reduced mass flux into the Memphis Sand aquifer. Conceptually, concentrations in the West and East Wells will become asymptotic, reflecting the source area remediation systems' operation, and then will begin to decrease as residual mass in the Memphis Sand aquifer is depleted.

The remediation systems at the MPA and NRS have been operational since 1995 and 1989, respectively. Given travel times in the Memphis Sand aquifer, mass removal activities at these two source areas should begin to have measurable impacts at the Town of Collierville well field beginning in 2002/2003, and should be evidenced by a leveling off and/or decrease in TCE concentrations measured at the Town of Collierville well heads through reduced mass flux into the aquifer. Groundwater data presented in the *2002/2003 Annual Progress Report* indicate that West Well concentrations have remained fairly stable from 2000 through 2002; concentrations in East Well continue to rise, but at a slower rate than the 1992 through 1998 time period and during 2003 actually equilibrated with West Well.

[7] Bulk sampling techniques were used during RI and RD events during the early 1990s. SW-846 Method 5035 sampling techniques, now regarded as standard in Region 4, have been noted to have significantly higher recovery than bulk sampling techniques. According to Hewitt, direct sampling techniques resulted in concentrations several orders of magnitude higher than bulk sampling techniques from collocated samples, with the largest discrepancies noted in clayey soil ("Collection, handling, and storage: Keys to improved data quality for volatile organic compounds in soil", *American Environmental Laboratory*, February 1995, 7 (1): 25-28. Hewitt, Alan D., Jenkins, Thomas F., and Grant, Clarence L.)

Data at this time do not reflect the decrease which will herald the ultimate reduction of residual mass; ongoing monitoring will be required to assess compliance with this RAO. However, the trend stabilization and ongoing mass removal at the MPA and NRS suggest that the restoration of groundwater RAO may be possible over the long term. Given the long travel times between the MPA and WP#2, short term shutdowns (e.g., of less than 2 years) will not affect the overall effectiveness of this remedy. As discussed in response to Question A, alternative source area treatment technologies do not offer significant benefit and are subject to permeability and access limitations. Therefore, compliance with the groundwater restoration RAO over the short term through a change in remedy is unlikely. Additional data collected during the next five-year period will be used to further assess the progress toward achieving this RAO.

Compliance with Prevention of Unauthorized Water Use RAO

Institutional controls are used to restrict access to groundwater contaminated with TCE at the Site. MSCHD rules regarding well installations prohibit installation of private wells within 0.5 miles of a federal or state Superfund site. Therefore, institutional controls continue to meet this RAO.

7.2.3 Changes in Land Use and Exposure Pathways

Land use at the Site is industrial and is not expected to change; adjacent properties along Byhalia Road and Poplar Avenue/Highway 72 are commercial/industrial. Existing and proposed mixed commercial/office/industrial properties are present west of the Site in the Schilling Farms development. Based on land use at the Site and surrounding area, no ecological receptors were identified as a concern and human exposure routes identified in the BRA have not changed, with the exception of vapor intrusion.

Since the BRA was performed in 1992, vapor intrusion has become an increasing concern for volatile compounds that could migrate from soil and/or groundwater into basements and buildings through cracks and other migration routes. Vapor intrusion could affect the protectiveness of the remedy, if it were not addressed. As described in Section 5, Carrier will

proactively install a SSV system during the ongoing plant expansion (Project Everest) to prevent vapor intrusion and corresponding worker exposures. Although the *2004 Five-Year Review* did not evaluate the vapor intrusion exposure pathway, the remedy remains protective as implemented based on the exposure pathways identified in the BRA.

Expansion of the facility has also eliminated dermal contact and ingestion pathways through expansion of the floor slab and surrounding truck apron. Therefore, though Site conditions have changed, overall, the potential for future exposure onsite has been reduced.

7.2.4 New Contaminants and/or Contaminant Sources

Contaminant and contaminant sources were assessed for both soil and groundwater.

Soil

As discussed in the RI and ROD, TCE contamination historically was associated with four discrete areas:

- The former wastewater treatment lagoon, the NRS
- The 1979 spill area, MPA
- The fire department wash down area from the 1979 spill, MPA
- The 1985 storage tank pipe leak area east of the Main Building, MPA

Active remediation systems were installed at the NRS and the 1979 spill area, where average TCE concentrations exceeded the 533 µg/kg criterion.

Sampling performed during 2004 and described in Section 5 confirmed the presence of contaminants in each of the known areas and verified that additional source areas were not present within the footprint of the Project Everest expansion area. Average concentrations in MPA the 1979 and 1985 spill areas were higher than those quantified during the RI and RD, likely due to the use of Method 5035 for sample collection. The increased concentrations do

not suggest the presence of new contaminant sources; rather, it implies that the contaminant source mass is larger than previously estimated.

Groundwater

Beginning in 2002, hexavalent chromium was detected in raw water at WP#2. As discussed in Section 4, the chromium source appears to be the Smalley-Piper Site. Increasing chromium concentrations led to the shutdown of WP#2 in December 2003. The Site remedy for WP#2 (air stripping) does not address chromium contamination. As outlined in the *Schedule for Interim Actions at Water Plant #2* (Appendix I) Carrier will evaluate technologies for chromium treatment during the 6-month interim operation period.

No new or additional sources of VOC contamination in groundwater have been suggested by Site data.

7.2.5 Remedy Degradation and Byproducts

TCE degradation products were anticipated during remedy selection, and no new byproducts have been discovered during the treatment process. Therefore, the protectiveness of the remedy would not be affected by degradation and/or byproducts.

7.2.6 Evaluation of Toxicity Factors and Contaminant Characteristics

As described in the *2000 Five-Year Review*, if the BRA was performed using current guidance, risk estimates based on TCE toxicity factors would be higher than those in 1992. The current magnitude of risk estimates is not known because TCE toxicity factors are under debate and agencies are currently reviewing available toxicological data. However, the TCE MCL has not been changed. Since the TCE MCL is the basis for the Site cleanup goals and the MCL has not changed, the protectiveness of the remedy would not be affected.

Risk assessment guidance has become more refined since 1992, which would affect risk estimates in this remedy. The *2000 Five-Year Review* summarized risk assessment differences. Methods to assess potential volatilization from soil or groundwater into buildings have become

integrated with most risk assessments for VOCs. The remedy which is being integrated with the Project Everest expansion includes SSV, which reduces the exposure potential for vapors. As a result, the protectiveness of this remedy would not be affected by changes in risk assessment methods.

7.2.7 Risk Recalculation/Reassessment

Because there have been no changes to the underlying standards used to develop cleanup goals at the Site, there is no need for risk recalculation/reassessment during this 5-year review.

Carrier has voluntarily modified the Site remedy to account for the evolving understanding of vapor migration through building foundations, as described in Section 5. The SSV system will eliminate the vapor migration pathway. As a result, it is not deemed necessary to perform additional evaluations to gauge vapor intrusion risks.

7.3 Evaluation of Question C — Has Any Other Information Emerged that Could Call into Question the Protectiveness of the Remedy?

As discussed in the ROD, no U.S. Department of Interior, State of Tennessee lands, or federally listed endangered species of wildlife were identified at the Site. TCE is not bioaccumulative and is not expected to cause deleterious food chain effects and, therefore, adverse ecological impacts to aquatic and terrestrial species through the contaminated food chain mechanism are not anticipated. A surface water quality assessment and a biological impact assessment were conducted during the RI. Data to date indicate no significant adverse ecological impacts from the present soil or groundwater contamination. With the Project Everest expansion, almost all contaminated soil will be covered by the manufacturing facility's foundation.

No natural disaster impacts to the Site have been reported. Flood plain redesignation of the region is not required.

No other information emerged that could call into question the protectiveness of the remedy.

7.4 Summary of Technical Assessment and Conclusion

The following conclusions summarize the status of the Site remedy following the *2004 Five-Year Review*:

- Site controls are adequate.

- Remedial systems onsite are functioning/performing properly, and will be enhanced by the reconstruction associated with the Project Everest expansion.

- The O&M for the NRS, MPA, and WP#2 are adequate at the Site.

- The results of the 2002 and 2004 soil sampling and analysis indicate that vadose soil in the MPA still contains concentration levels higher than the ROD cleanup criteria of 533 µg/kg. These data will be used to target vapor extraction efforts on the contaminated zones.

- The reconstruction of the MPA SVE system is in accordance with the Site decision documents and meets the RAOs as defined in ROD. The reconstructed MPA system will provide maximum flexibility in targeting recalcitrant zones.

- Groundwater data from MW-31 indicated a decrease in TCE concentration since the 1991 maximum value of 1,100 µg/L, suggesting that the MPA is reducing mass flux to groundwater.

- Results of sampling from MW-60 and MW-62 indicate no traces of TCE in either well. The absence of contamination at MW-60 and MW-62 indicates that effective capture is maintained at the current pumping rate, shared by the two WP#2 production wells.

- The WP#2 well field functions as an effective groundwater containment system for the Carrier TCE plume.

- Resolution of the long-term discharge for WP#2 and associated chromium issues will be required to ensure continuing containment of the TCE plume.

- No early indicators of potential remedy failure have been identified for any component of the Site remedy.

- O&M costs have been low but are expected to increase due to the Smalley-Piper chromium issue.

8.0 ISSUES

The following issues were identified during the *2004 Five-Year Review*:

- Carrier and the Town of Collierville need to maintain the working relationship required to ensure continuous operation of WP#2. The delays in communication originally noted in the *2000 Five-Year Review* were again noted during the initial stages of the chromium problem (2002, early 2003). Communication issues do not affect the remedy's protectiveness at this time. Future delays in communication and/or failure to recognize WP#2's critical role in the Site remedy could affect the remedy's protectiveness in the future.

- Resolution of the chromium problem is required to ensure that a continuous, long-term discharge option is available for WP#2. As indicated in previous sections, WP#2 is an integral part of the containment remedy at the Site. Because the short-term interim remedy is in place, the chromium plume does not affect the remedy's protectiveness at this time. This system will continue to operate and a long-term discharge option will be identified and implemented. Delays in resolving the chromium problem, including failure to resolve a long-term discharge option, will likely affect the remedy's protectiveness in the future.

- Following completion of the Project Everest expansion, Carrier will be required to submit construction as-builts and associated documentation for the MPA replacement system and the SSV system. Documentation of expansion-related activities does not affect Site protectiveness currently or in the future.

- During preparation for expansion activities, Memphis Sand monitoring well MW-10 was sampled prior to final determination of the need for closure. Analytical results for this well indicated high concentrations of TCE (exceeding 10,000 µg/L) during two separate sampling events. Additional evaluation of this well must be completed to determine if analytical data are truly representative of the Memphis Sand aquifer or if, due to the age

of the well, monitoring well failure has occurred. Evaluation of MW-10 does not preclude Site protectiveness now or in the future, as the WP#2 system provides adequate groundwater containment.

- During its review of the *2004 Five Year Review*, TDEC expressed concerns regarding the potential presence of private/residential wells downgradient of the Carrier site. Carrier has not re-evaluated the presence and usage of downgradient wells since the RI/FS. TDEC will pursue inquiries with the Memphis and Shelby County Health Department, which regulates private well construction in Shelby County.

- Both USEPA and TDEC expressed concerns about MW-31's demolition in 2000 and the potential need to replace the well and/or continue monitoring in this portion of the site. Additional evaluation of this well location is required to gauge protectiveness with respect to the Site remedy.

9.0 RECOMMENDATIONS AND FOLLOW-UP ACTIONS

Recommendations and follow-up actions are identified below:

- Carrier and the Town of Collierville need to maintain the working relationship required to ensure continuous operation of WP#2. Carrier will take the lead in strengthening the relationship with the Town of Collierville, with oversight and support from USEPA and TDEC. No milestone is associated with this task, as it will require ongoing commitment from both parties.

- Resolution of the chromium problem is required to ensure that a continuous, long-term discharge options is available for WP#2. Carrier has taken the lead in pursuing alternative discharge options to date and will continue to work with the Town of Collierville, USEPA, and TDEC to resolve the discharge issue. Smalley-Piper Potentially Responsible Parties (PRPs) may also be required to participate in operation of a chromium treatment system.

- Following completion of the Project Everest expansion, Carrier will submit construction as-builts and all associated documentation for the MPA replacement system and the SSV system. The milestone date for this task is December 31, 2005.

- Carrier will continue to submit annual reports documenting Site activities. Annual reports will be submitted by June 1 of the subsequent year.[8]

- Carrier will evaluate the integrity of MW-10 to determine whether TCE detected in this well during 2004 is representative of the Memphis Sand aquifer. This analysis will be completed during 2005 and documented in the 2005 annual report.

[8] As noted in a February 28, 2005, conference call with USEPA and TDEC, the 2004 Five-Year Review will be acceptable in lieu of a 2004 annual report.

- TDEC will pursue inquiries with the Memphis and Shelby County Health Department, which regulates private well construction in Shelby County, to assess the number and type of private wells downgradient of the Carrier facility. This analysis will be shared with USEPA and Carrier when complete.

- Carrier will evaluate the need to monitor/replace MW-31. Rationale will be discussed with USEPA and TDEC, and a recommendation will be proposed to both agencies by August 31, 2005.

10.0 PROTECTIVENESS STATEMENT

The remedies implemented at the MPA, NRS, and WP#2 at the Carrier facility are protective of human health and the environment. Results of the 5-year review indicate that:

- Significant mass reduction has occurred at the MPA and NRS source areas since the systems were installed. Mass removal at the two SVE treatment areas has been or will be enhanced through system reconstruction and optimization.

- Integration of the SSV system into the Project Everest expansion has eliminated concerns regarding vapor migration.

- TCE concentrations at WP#2 have stabilized in the 150 to 200 µg/L range for both wells. Downgradient compliance monitoring wells MW-60 and MW-62 do not exhibit TCE contamination. These data indicate that the well field is capturing contaminants originating from the MPA.

- Interim and projected future operations at WP#2 will be sufficient to contain the TCE plume; containment at WP#2 will be required over the long term but will be complicated by the presence of hexavalent chromium associated with the Smalley-Piper Site.

Conditions at the Site are not expected to change in the near future, given the area's land use (industrial/commercial) and zoning controls currently in place.

11.0 NEXT REVIEW

The next statutory review for the Collierville Site will be required in 2010, 5 years from the completion date (e.g., signature date) of this 5-year review report.

Appendix A
Figures

1,000 Feet

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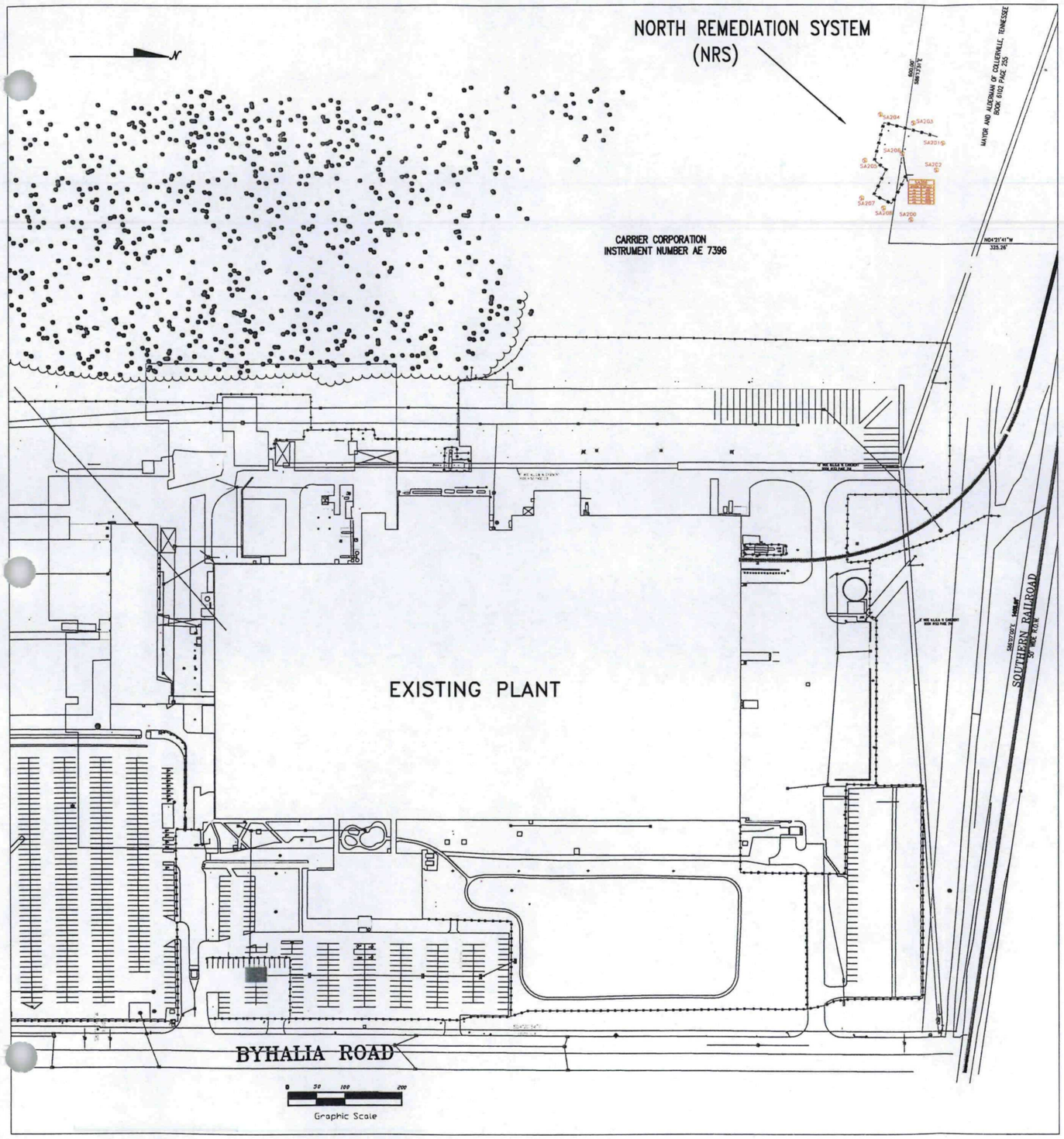
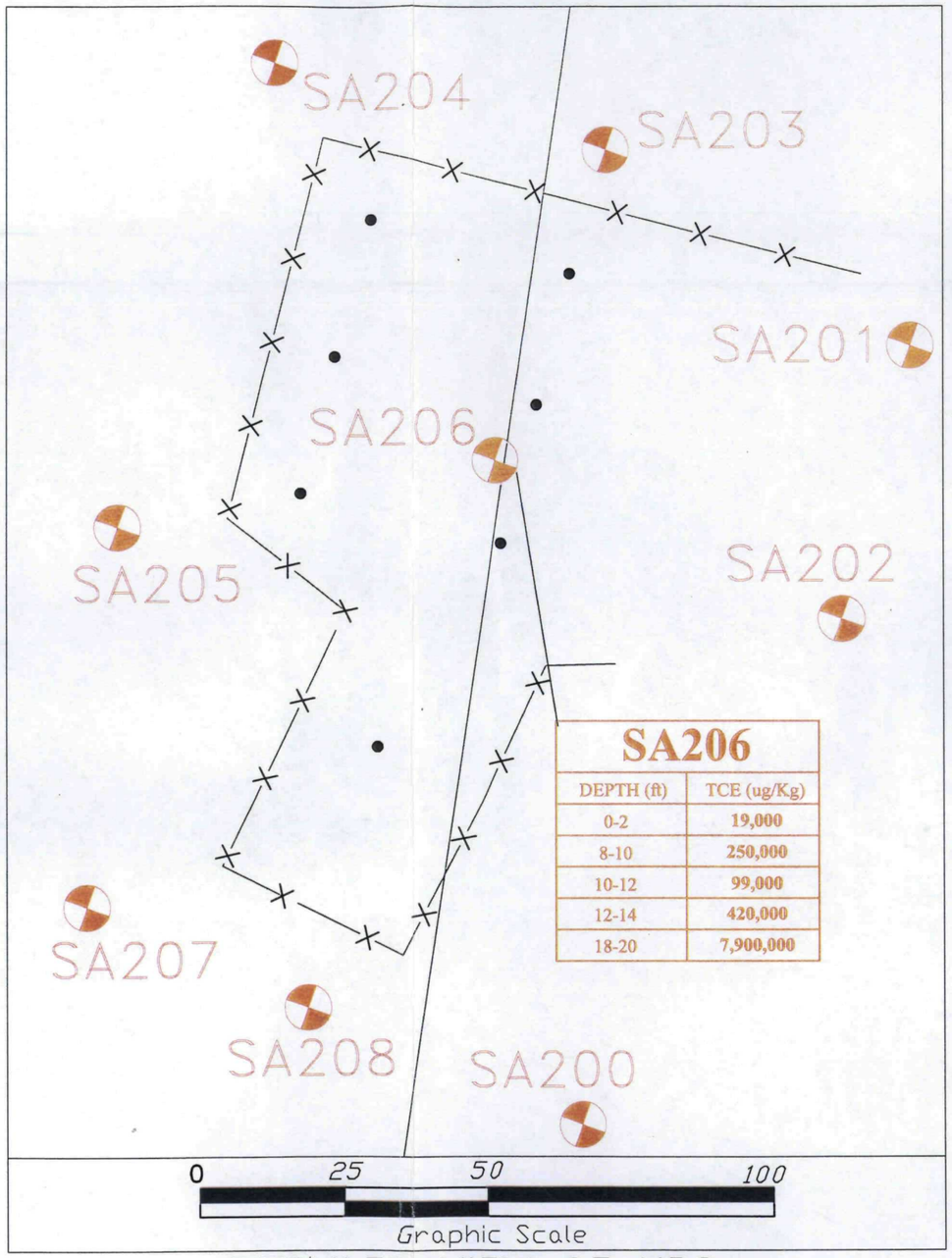
ENSAFE

Figure 3-1
Site Location Map
Carrier Collierville Site
Collierville, Tennessee



SITE MAP



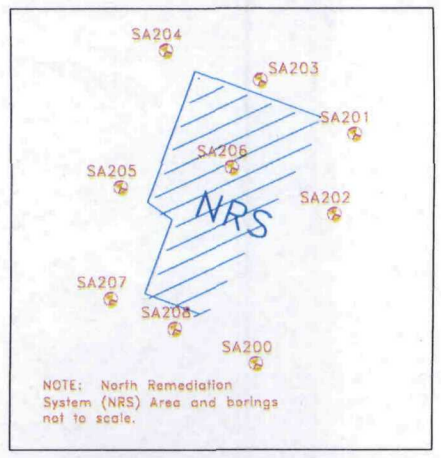
SA206

DEPTH (ft)	TCE (ug/Kg)
0-2	19,000
8-10	250,000
10-12	99,000
12-14	420,000
18-20	7,900,000

DETAILED VIEW OF NRS

XPERT DESIGN AND DIAGNOSTICS, LLC

SCALE: As Shown	TITLE: NRS SOIL BORING LOCATIONS & TCE EXCEEDANCES (TCE > 533 ug/Kg)
DATE: SEPTEMBER 14, 2004	
PROJECT NO.: 73271	
CLIENT: UTC – COLLIERVILLE	
DRAWN BY: MTT	DRAWING NO. FIGURE 5–1
CHECKED BY:	REV. A
PROJ. MGMT. APPROVAL:	



NORTH REMEDIATION SYSTEM (NRS)
2004 SOIL BORING LOCATIONS

ECB

Building F
(Plant 2)

MAIN PLANT
REMEDIATION AREA

EXISTING MAIN
PLANT BUILDING

Existing San/Sewer

Existing Sewer/Water Lines

LEGEND

- Sewer Drain
- Sewer/Water Line
- Water Well
- Fence
- Existing Structure

SOIL BORING KEY:

- SUSPECT AREA (SA) – borings located in historic and suspected TCE impact areas of proposed excavation and demolition; 50 feet on-center and 16 feet BGS, typical.
- INSIDE EXPANSION AREA (IE) – borings located in planned expansion area;100 feet on-center and 4 feet BGS, typical.
- OUTSIDE EXPANSION AREA (OE) – borings located outside planned expansion area but near planned excavation and demolition; 100 feet on-center and 4 feet BGS, typical.

NOTES

- Original drawing courtesy of Burr & Cole.
- Location of NRS is not to scale.
- All "OE," "IE," and "SA" borings were completed in April 2004.

Graphic Scale
0 60 120 240

XPERT DESIGN AND DIAGNOSTICS, LLC

SCALE: As Shown	TITLE: SOIL SURVEY BORING LOCATIONS
DATE: JUNE 14, 2004	
PROJECT No.: 73271	
CLIENT: UTC – COLLIERVILLE	
DRAWN BY: MTT	DRAWING NO. FIGURE 5-2
CHECKED BY: OU	REV. A
PROJ. MGMT. APPROVAL:	

N

EXISTING MAIN
PLANT BUILDING

ECB

Building F
(Plant 2)

533
1,000
10,000
100,000

LEGEND

•OE8 Fence

Existing Structure

Contour Interval
(ug/Kg TCE) (2004)

SOIL BORING KEY:

•OE5 BORING WITH NONDETECT RESULTS (2004)

•OE12 BORINGS WITH RESULTS ABOVE NONDETECT. (2004)

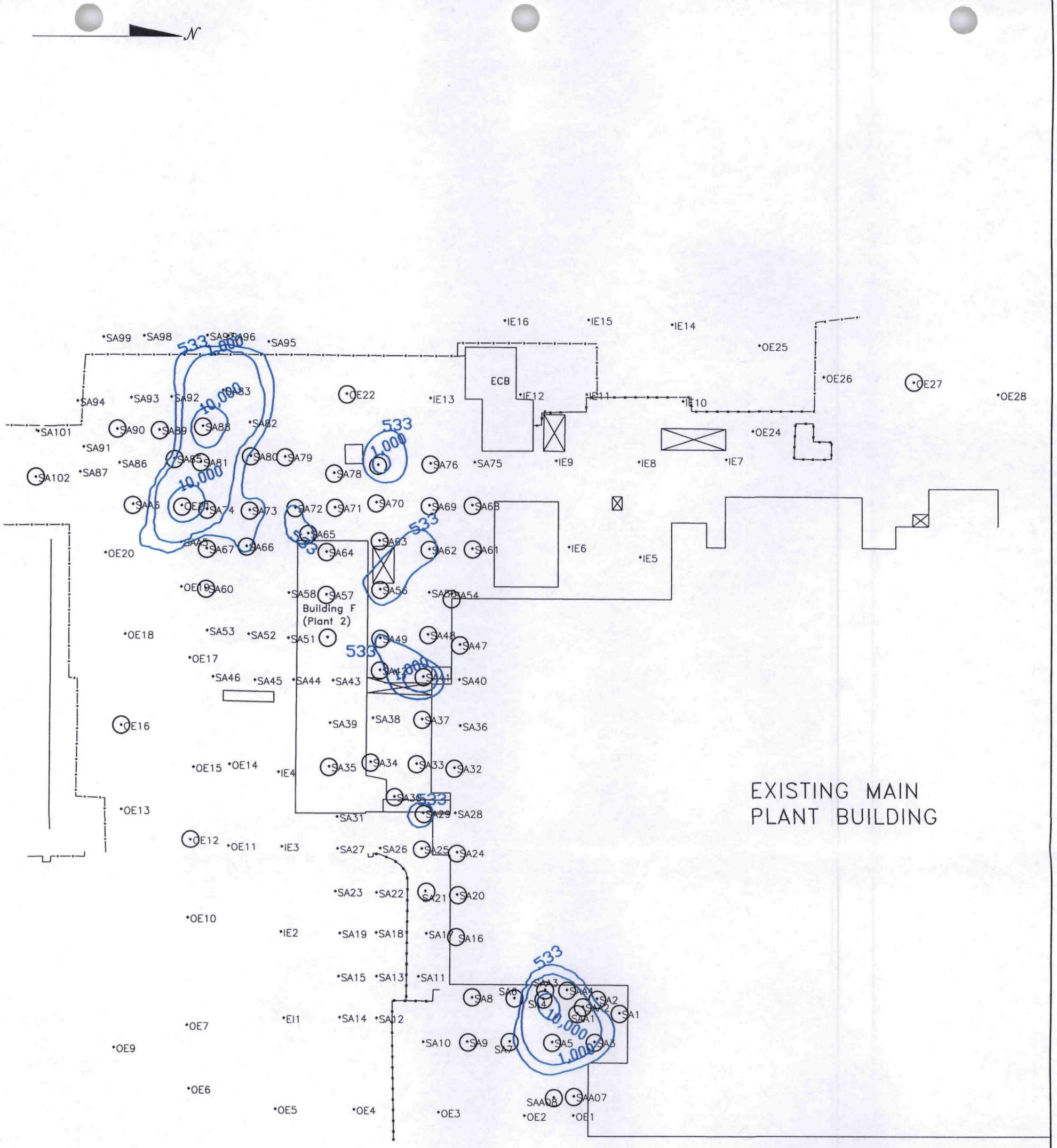
NOTES

- *Original drawing courtesy of Burr & Cole.*
- *Location of NRS borings is not included.*
- No borings exceed 20 feet BGS.
- Contours were developed using GMS Software – 3D kriging model.
- Only borings with results > ND were used in the model.
- *3D Contours were developed at 2' vertical intervals. The* composite contours in this figure represent the greatest horizontal area in the 0–6' BGS range.

Graphic Scale
0 60 120 240

XPERT DESIGN AND DIAGNOSTICS, LLC

Scale: As Shown	Title: MPA SOIL SURVEY RESULTS TCE CONTOURS FOR 0–6' BGS (ug/Kg)
Date: JULY 20, 2004	
Project No.: 73271	
Client: UTC – COLLIERVILLE	
Drawn By: MTT	Drawing No. FIGURE 5–3
Checked By:	Rev. D
Proj. Mgmt. Approval:	



LEGEND

- Fence
- Existing Structure
- Contour Interval (ug/Kg TCE) (2004)

SOIL BORING KEY:

- •OE5 BORING WITH NONDETECT RESULTS (2004)
- •OE12 BORINGS WITH RESULTS ABOVE NONDETECT. (2004)

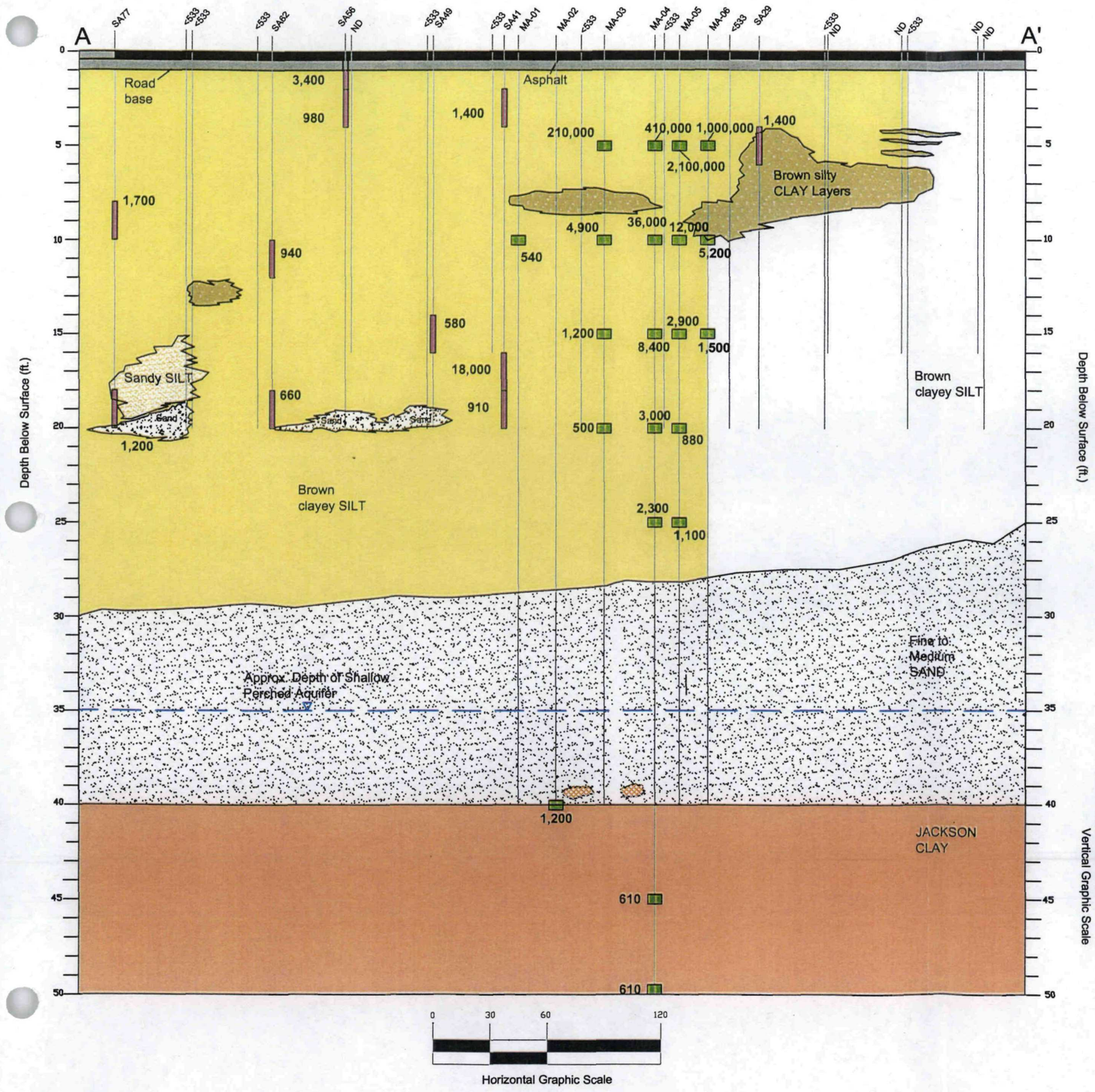
NOTES

- *Original drawing courtesy of Burr & Cole.*
- *Location of NRS borings* is not included.
- No borings exceed 20 feet BGS.
- Contours were developed using GMS Software – 3D kriging model.
- Only borings with results > ND were used in the model.
- 3D Contours were developed in 2' vertical intervals. The composite contours in this figure represent the greatest horizontal area in the 6–20' BGS range.

Graphic Scale
0 60 120 240

XPERT DESIGN AND DIAGNOSTICS, LLC

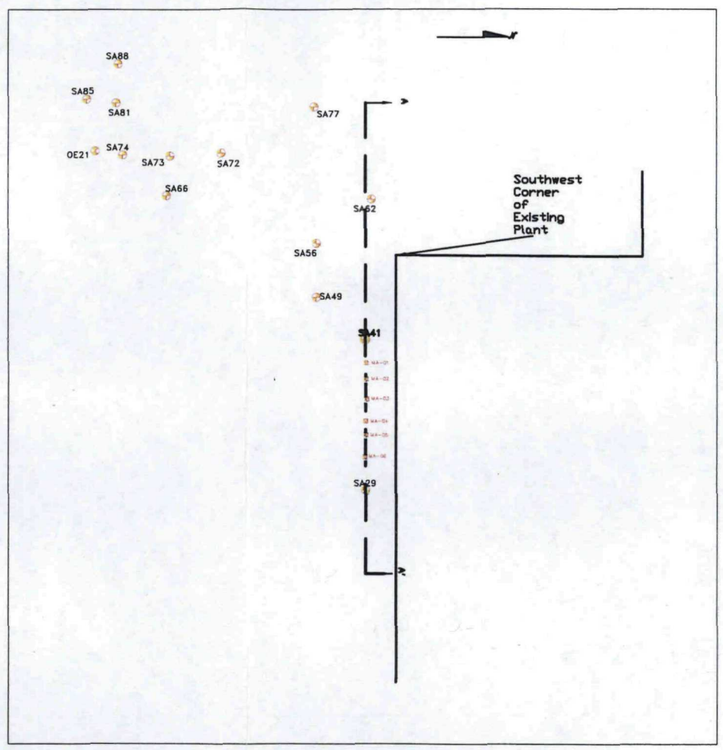
SCALE: As Shown	TITLE: MPA SOIL SURVEY RESULTS TCE CONTOURS FOR 6–20' BGS (ug/Kg)
DATE: JULY 20, 2004	
PROJECT NO.: 73271	
CLIENT: UTC – COLLIERVILLE	
DRAWN BY: MTT	DRAWING NO. FIGURE 5–4 / REV. D
CHECKED BY:	
PROJ. MGMT. APPROVAL:	



NOTES

- Boring samples with TCE Exceedance (> 533 ug/Kg) based on 2004 Data
- Boring samples with TCE Exceedance (> 533 ug/Kg) based on 2002 Data
- ND — Boring samples where TCE was non detect (0-20' BGS) - 2004 Data
- <533 — Boring samples where TCE was below 533 ug/Kg - 2004 Data

LOCATION MAP



XPERT DESIGN AND DIAGNOSTICS, LLC

SCALE: As Shown	TITLE: MPA GEOLOGIC CROSS-SECTION & TCE DISTRIBUTION
DATE: JULY 20, 2004	UTC – Carrier Air Conditioning Collierville,TN
PROJECT No.: 73271	
CLIENT: UTC – COLLIERVILLE	
DRAWN BY: PJC	
CHECKED BY: OU	FIGURE: FIGURE 5-5 — REV.: D
PROJ. MGMT. APPROVAL:	

N

NEW TRAILER PARKING AREA

ECB

Building F
(Plant 2)

"HOT ZONE"

EXISTING MAIN
PLANT BUILDING

LEGEND

~ Fence

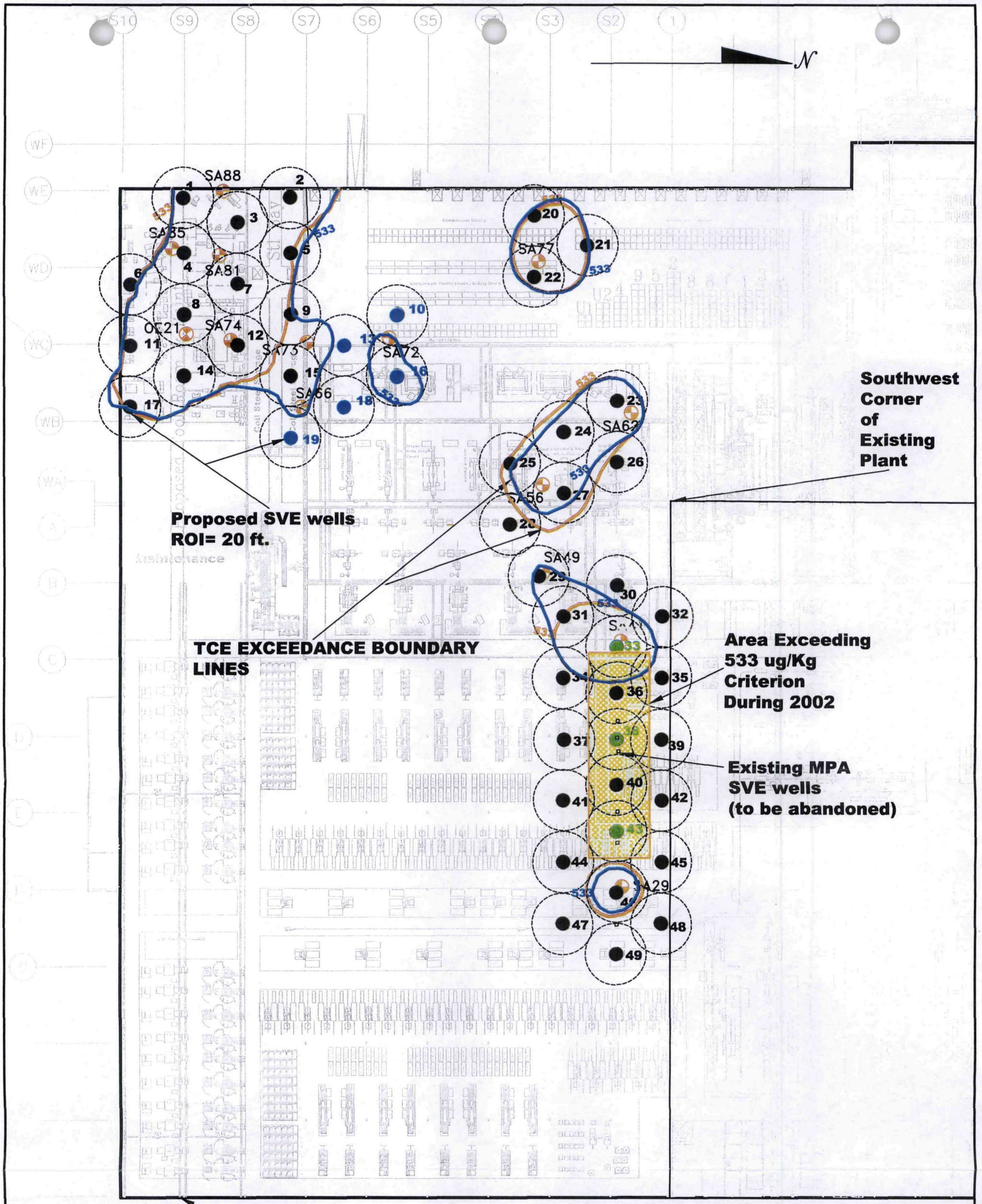
— Existing Structure

Area of 300,000 square foot expansion

Graphic Scale

XPERT DESIGN AND DIAGNOSTICS, LLC

SCALE: 1:120	TITLE: Soil Management Plan Area
DATE: JULY 20, 2004	
PROJECT NO.: 73271	
CLIENT: UTC – COLLIERVILLE	
DRAWN BY: MTT	DRAWING NO. FIGURE 5–6
CHECKED BY:	REV. A
PROJ. MGMT. APPROVAL:	



LEGEND

- Geoprobe Point > 533 ug/Kg TCE (2004)
- TCE 533 ug/Kg Contour Line 0 – 6 FT BGS (2004)
- TCE 533 ug/Kg Contour Line 6 – 20 FT BGS (2004)
- Proposed Multilevel Soil Vapor Extraction Wells (Shallow, Deep, and Deep Sand)
- Proposed Dual Level Soil Vapor Extraction Wells (Shallow and Deep)
- Proposed Single Level Soil Vapor Extraction Well (Deep)
- Area of influence of proposed MPA SVE system

NOTES Soil Vapor Extraction Wells are generally spaced (</=) 40 feet on center.
ROI = Radius of Influence

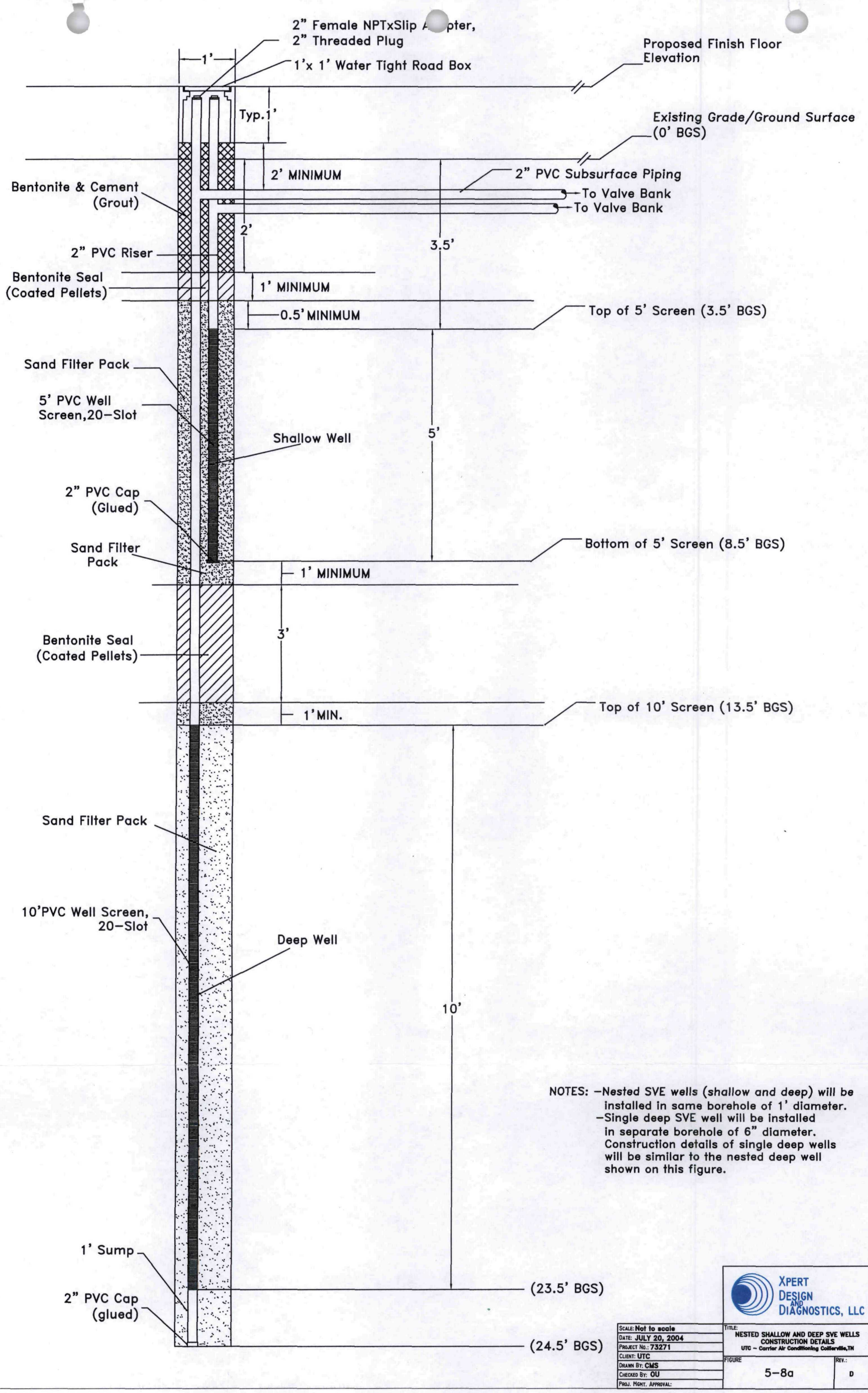
GRAPHIC SCALE

0 30 60 120

1 inch = 60 ft.

XPERT DESIGN AND DIAGNOSTICS, LLC

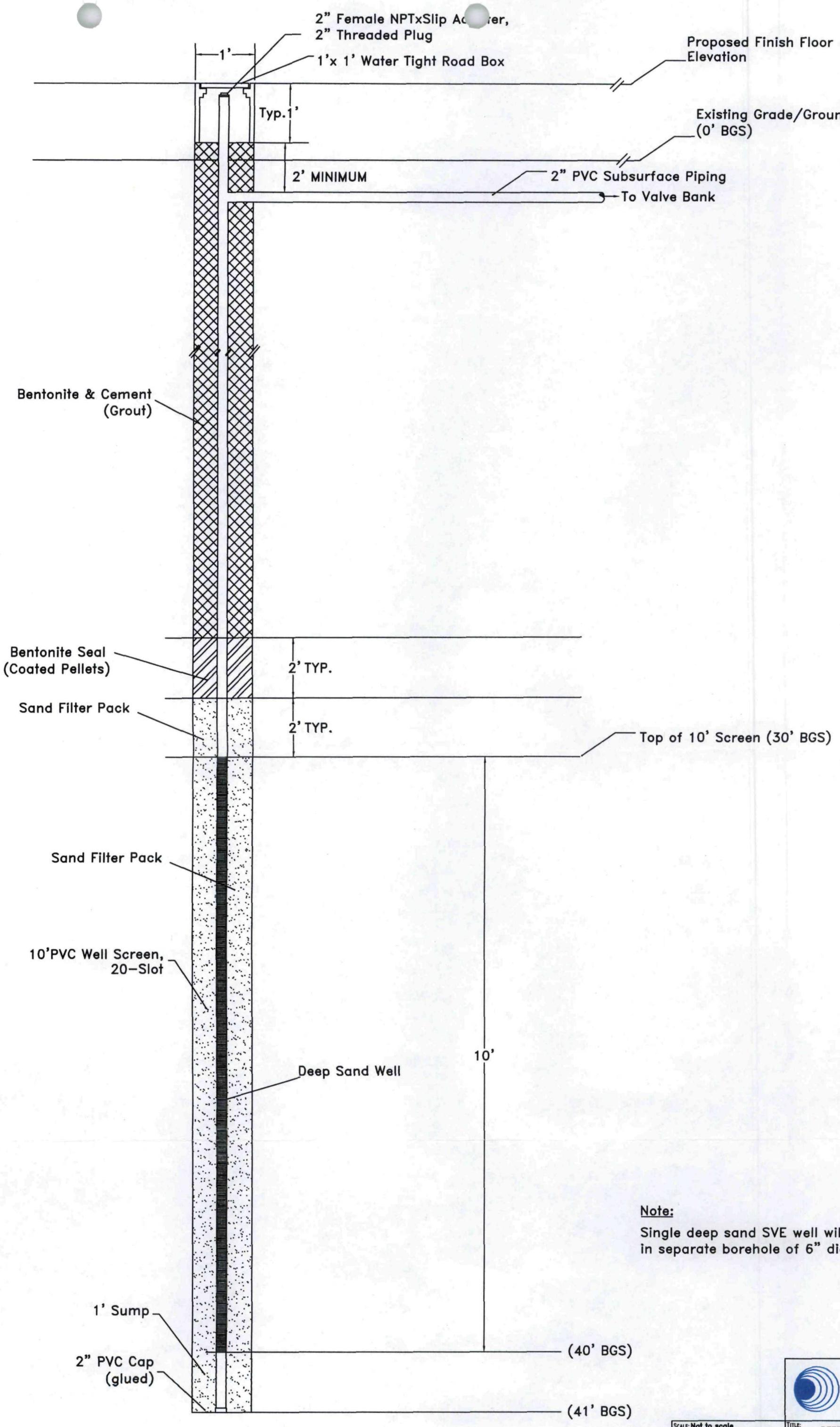
SCALE: As shown	TITLE: SVE TREATMENT AREAS – MPA UTC – Carrier Air Conditioning Collierville, TN
DATE: JULY 20, 2004	
PROJECT NO.: 73271	
CLIENT: UTC – COLLIERVILLE	
DRAWN BY: MTT	FIGURE 5-7
CHECKED BY: OU	REV. D
PROJ. MGMT. APPROVAL:	



NOTES: -Nested SVE wells (shallow and deep) will be installed in same borehole of 1' diameter.
-Single deep SVE well will be installed in separate borehole of 6" diameter. Construction details of single deep wells will be similar to the nested deep well shown on this figure.

XPERT DESIGN AND DIAGNOSTICS, LLC

SCALE: Not to scale	TITLE: NESTED SHALLOW AND DEEP SVE WELLS CONSTRUCTION DETAILS UTC – Carrier Air Conditioning Collierville,TN
DATE: JULY 20, 2004	
PROJECT NO.: 73271	
CLIENT: UTC	
DRAWN BY: CMS	FIGURE: 5-8a
CHECKED BY: OU	REV.: D
PROJ. MGMT. APPROVAL:	

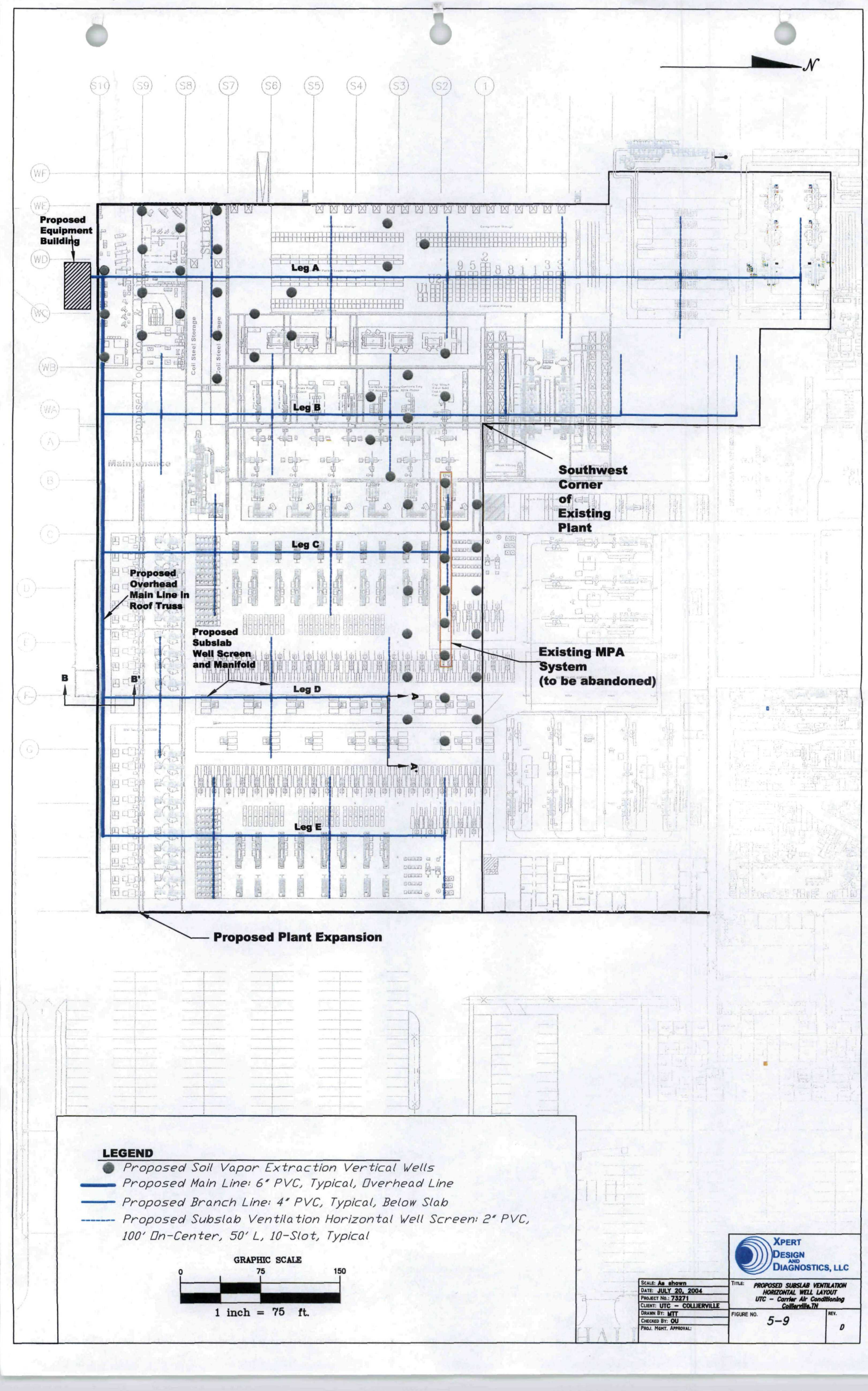


Note:

Single deep sand SVE well will be installed in separate borehole of 6" diameter.

XPERT DESIGN AND DIAGNOSTICS, LLC

SCALE: Not to scale	TITLE: DEEP SAND SVE WELL CONSTRUCTION DETAILS UTC – Carrier Air Conditioning Collierville,TN
DATE: JULY 20, 2004	
PROJECT NO.: 73271	
CLIENT: UTC	
DRAWN BY: PJC	
CHECKED BY: OU	
PROJ. MGMT. APPROVAL:	FIGURE 5-8b / REV.: D



LEGEND

- Proposed Soil Vapor Extraction Vertical Wells
- Proposed Main Line: 6" PVC, Typical, Overhead Line
- Proposed Branch Line: 4" PVC, Typical, Below Slab
- Proposed Subslab Ventilation Horizontal Well Screen: 2" PVC, 100' On-Center, 50' L, 10-Slot, Typical

GRAPHIC SCALE

0 — 75 — 150

1 inch = 75 ft.

XPERT DESIGN AND DIAGNOSTICS, LLC

SCALE: As shown	TITLE: PROPOSED SUBSLAB VENTILATION HORIZONTAL WELL LAYOUT UTC – Carrier Air Conditioning Collierville,TN
DATE: JULY 20, 2004	
PROJECT NO.: 73271	
CLIENT: UTC – COLLIERVILLE	
DRAWN BY: MTT	FIGURE NO. 5-9
CHECKED BY: OU	REV. D
PROJ. MGMT. APPROVAL:	